U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-266 912

Fractional Efficiency of an Electric Arc Furnace Baghouse

GCA Corp, Bedford, Mass GCA Technology Div

Prepared for

Industrial Environmental Research Lab, Research Triangle Park, N C

Mar 77

PB 266 912

EPA

FRACTIONAL EFFICIENCY OF AN ELECTRIC ARC FURNACE BAGHOUSE

Interagency
Energy-Environment
Research and Development
Program Report

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.
EPA-600/7-77-023

2.

3. RECIPIENT'S ACCESSION NO.

4. TITLE AND SUBTITLE
FRACTIONAL EFFICIENCY OF AN ELECTRIC ARC FURNACE BAGHOUSE

5. REPORT DATE
March 1977

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
Reed W. Cass and John E. Langley

8. PERFORMING ORGANIZATION REPORT NO.
GCA-TR-76-34-G

9. PERFORMING ORGANIZATION NAME AND ADDRESS
GCA/Technology Division
Burlington Road
Bedford, Massachusetts 01730

10. PROGRAM ELEMENT NO.
EHE624

11. CONTRACT/GRANT NO.
68-02-1438, Task 4

12. SPONSORING AGENCY NAME AND ADDRESS
EPA, Office of Research and Development
Industrial Environmental Research Laboratory
Research Triangle Park, NC 27711

13. TYPE OF REPORT AND PERIOD COVERED
Task Final; 6/5/74-2/77

14. SPONSORING AGENCY CODE
EPA/600/13

15. SUPPLEMENTARY NOTES IERL-RTP task officer for this report is J.H. Turner, Mail Drop 61, 919/549-8411 Ext 2925.

16. ABSTRACT

The report gives results of an evaluation of the performance of a fabric filter system controlling emissions from either one or two 30-ton electric arc furnaces producing a high-strength, low-alloy specialty steel. The evaluation involved measuring the system's total mass collection efficiency and apparent fractional collection efficiency. Testing involved 8 sampling days with one furnace operating, and 2 days with two furnaces. Baghouse influent and effluent streams were sampled with total mass samplers, inertial impactors, a condensation nuclei counter (CNC), and an optical dust counter. The influent and effluent total fluoride concentrations were measured for three of the tests to estimate the particulate and gaseous fluoride levels to which the Dacron filter bags are exposed during normal service Total mass tests showed baghouse mean mass efficiency to be 97.9% with one furnace operating, and 98.7% with two furnaces. Mean mass concentrations for one- and two-furnace operation were 0.0014 and 0.0019 grains/dscf, respectively. Influent impactor tests showed considerable size distribution differences as a function of the phase of the process: the greatest concentrations for the particles sized occurred during the first melt. Effluent impactor size distribution tests suggested agglomeration.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution	Air Pollution Control	13B
Dust	Stationary Sources	11G
Polyester Fibers	Fabric Filters	11E
Fabrics	Baghouses	
Filtration	Fractional Efficiency	07D
Electric Arc Furnaces		13A

18. DISTRIBUTION STATEMENT
Unlimited

19. SECURITY CLASS *(This Report)*
Unclassified

20. SECURITY CLASS *(This page)*
Unclassified

21. NO. OF PAGES
187

22. PRICE
PCA09 / MF A01

EPA Form 2220-1 (9-73)

Reproduced from best available copy.

ib

EPA-600/7-77-023
March 1977

FRACTIONAL EFFICIENCY
OF AN ELECTRIC ARC
FURNACE BAGHOUSE

by

Reed W. Cass and John E. Langley

GCA/Technology Division
Burlington Road
Bedford, Massachusetts 01730

Contract No. 68-02-1438, Task 4
Program Element No. EHE624

EPA Task Officer: James H. Turner

Industrial Environmental Research Laboratory
Office of Energy, Minerals, and Industry
Research Triangle Park, NC 27711

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Washington, DC 20460

ATTENTION

AS NOTED IN THE NTIS ANNOUNCEMENT, PORTIONS OF THIS REPORT ARE NOT LEGIBLE. HOWEVER, IT IS THE BEST REPRODUCTION AVAILABLE FROM THE COPY SENT TO NTIS.

TABLE OF CONTENTS

Page

Sections

I Conclusions 1

II Recommendations 3

III Introduction 4

IV Marathon LeTourneau Steel Mill 6

V Equipment and Methods 11

VI Results 29

VII References 56

Appendix

A Particle Size Distribution Curves 57

B Differential Size Distribution Curves 69

C Andersen In-Stack Impactor Substrate Anomalous Weight Gains 81

D Calculator Inputs/Outputs for Total Mass Measurements 89

E Calculator Inputs/Outputs for Inertial Impactor Measurements 110

F Fine Particle Measurements 151

LIST OF FIGURES

No.		Page
1	Photograph of Side of Fabric Filter	7
2	Photograph of End of Fabric Filter	8
3	Location of Baghouse Inlet Test Ports and Sampling Points	12
4	Location of Baghouse Outlet Test Ports and Sampling Points in North Stack	13
5	Photograph of Inlet Sampling Location	14
6	Photograph of Outlet Sampling Location	15
7	Andersen Impactor Manufacturer's Curves and Measured Stage Size Cutoff Points as a Function of Flow Rate	19
8	Correlation Between the Outlet Mass Concentrations Determined by the RAC Stack Sampler and the Inertial Impactor and Prefilter	24
9	Fine Particle Dilution System Components	27
10	Inlet Concentration as a Function of Events in the Process Cycle	33
11	Time in Process Cycle at Which Inlet Samples Were Collected	35
12	Inlet MMD as a Function of Process Cycle and Testing Day	36
13a	Differential Size Distribution Curves of Baghouse Inlet Aerosol During First Melt Phase of Process Cycle When One Electric Arc Furnace is Operating	37
13b	Differential Size Distribution Curves of Baghouse Inlet Aerosol During Back Charge Phase of Process Cycle When One Electric Arc Furnace is Operating	38

LIST OF FIGURES (continued)

No.		Page
13c	Differential Size Distribution Curves of Baghouse Inlet Aerosol During Second Melt Phase of Process Cycle When One Electric Arc Furnace is Operating	39
13d	Differential Size Distribution Curves of Baghouse Inlet Aerosol During Tap Phase of Process Cycle When One Electric Arc Furnace is Operating	40
14	Composited Differential Size Distribution Curves of Baghouse Inlet Aerosol For a Process Cycle With One and Two Furnaces Operating (190 Minute Furnace Cycle)	42
15a	Concentration Versus Process Cycle for 1 μm Particles	43
15b	Concentration Versus Process Cycle For 2 μm Particles	44
15c	Concentration Versus Process Cycle For 4 μm Particles	45
15d	Concentration Versus Process Cycle For 6 μm Particles	46
15e	Concentration Versus Process Cycle For 8 μm Particles	47
15f	Concentration Versus Process Cycle For 10 μm Particles	48
16	Average Outlet Differential Size Distribution Curves For Tests With One and Two Furnaces Operating	49
17	Fabric Filter Fractional Penetration Curves	50
18	Condensation Nuclei Counter Measured Concentrations as a Function of the Process Cycle and Compartment Cleaning	54
19	Dust Counter Measured Concentrations as a Function of the Process Cycle and Compartment Cleaning	55

LIST OF TABLES

No.		Page
1	Results of Physical Characterization Tests On Fabric Filter Bags	10
2	Velocities in Fabric Filter Inlet Duct	16
3	Impactor Calibration Parameters	18
4	Probe Losses of Impactors Sampling the Fabric Filter Influent and Effluent	21
5	Results of Particulate Sampling at Marathon LeTourneau	30
6	Flue Gas Properties	32
7	Outlet Concentration and Penetration Statistics	31
8	Results of Fluoride Analyses	51
9	Results of Fine Particle Measurements on the Baghouse Influent and Effluent at Marathon LeTourneau	53

CONVERSION FACTORS FOR BRITISH AND METRIC UNITS

To convert from	To	Multiply by	To	Multiply by
^oF	^oC	$\frac{5}{9}$ (^{o}F-32)	—	—
ft.	meters	0.305	centimeters	30.5
ft.^{2}	meters^2	0.0929	centimeters^2	929.0
ft.^{3}	meters^3	0.0283	centimeters^3	28,300.0
ft./min. (fpm)	centimeters/sec.	0.508	meters/sec.	5.08×10^{-3}
ft.^{3}/min.	centimeters^3/sec.	471.9	meters^3/hr.	1.70
in.	centimeters	2.54	meters	2.54×10^{-2}
in.^{2}	centimeters^2	6.45	meters^2	6.45×10^{-4}
oz.	grams	28.34	grains	438.0
oz./yd.^{2}	grams/meter^2	33.89	grams/centimeter^2	3.39×10^{-3}
grains	grams	0.0647	—	—
grains/ft.^{2}	grams/meter^2	0.698	—	—
grains/ft.^{3}	grams/meter^3	2.288	—	—
lb. force	dynes	4.44×10^5	Newtons	0.44
lb. mass	kilograms	0.454	grams	454.0
lb./ft.^{2}	grams/centimeter^2	0.488	grams/meter^2	4,880.0
in. H_2O/ft./min.	cm. H_2O/cm/sec.	5.00	Newtons/meter^2/cm/sec.	490.0
Btu	calories	252	—	—

ACKNOWLEDGMENTS

The many contributions of Dr. James H. Turner, Environmental Protection Agency Project Officer, are gratefully appreciated. The outstanding cooperation of Mr. David H. Thomas and the staff of the Marathon LeTourneau Steel Mill, especially Mr. William McClelland and Mr. James Hodges made this program possible and is sincerely appreciated.

Several members of the GCA/Technology Division staff made significant contributions to the field program. They include Messrs. Stephen Brenan, Mark Daniels, Robert Engelman and Manuel Rei.

The GCA/Technology Division Administrator was Mr. Norman F. Surprenant and the project manager was Mr. Robert M. Bradway.

SECTION I

CONCLUSIONS

The test results show that a fabric filter utilizing two year old Dacron$^{\text{TM}}$ bags is an effective means of controlling particulate emissions from the electric arc furnace tested which produces a high strength, low alloy specially steel. The results of the tests with one and two furnaces operating determined the baghouse mean mass removal efficiencies to be 97.9 percent and 98.7 percent, respectively, corresponding to mean effluent concentrations of 0.0014 and 0.0019 grains/dscf.[*] The maximum effluent concentrations for the total mass samples for the tests with one and two furnaces in operation were 0.0016 and 0.0021 gr/dscf, respectively. These effluent concentrations are well within the Environmental Protection Agency's Standard of Performance for Steel Plants: Electric Arc Furnaces Standard for Particulate Matter of 0.0052 gr/dscf.[1]

The findings of the baghouse influent and effluent inertial sizing measurements were contrary to what would be predicted by fabric filtration theory based on interception and inertial and differential capture mechanisms. The fact that the particles with aerodynamic diameters of 6 μm exhibited the highest penetration and particles of 1 μm the least penetration through the baghouse suggests agglomeration of the smaller particles. These results support the contention that a large percentage of particles in the fabric filter effluent have not passed directly through the filter media but instead are dislodged agglomerated particles which were previously collected.

---

[*] Although it is EPA's policy to use the metric system for quantitative descriptions, the British system is used in this report because not to do so would tend to confuse the reader. Readers who are more accustomed to metric units may use the table of conversions on the preceding page.

The time of maximum condensation nuclei emissions from the baghouse was determined to be immediately after compartment cleaning. This time was pinpointed by monitoring the stack aerosol with real time particle counters. The period immediately following compartment cleaning is a time of maximum emissions for a properly functioning filtration system because the filter cake is removed or damaged during cleaning and the fabric is least efficient until the cake has been repaired or replaced.

SECTION II

RECOMMENDATIONS

It is recommended that the experience of personnel operating and maintaining fabric filters be compiled emphasizing the methods of detecting and locating defective bags. This problem was pointed out during the subject program when an inspection of each compartment made it apparent that the presence of a leaking bag would be nearly impossible to detect. The thimble plates had considerable buildup of dust and a loose bag would likely go unnoticed. A leaking bag was in fact discovered several weeks after the test program was completed, but it is impossible to determine if the bag was leaking at the time of the tests. It would also be useful to find out when an operator feels it is necessary to replace a leaking bag and what levels of emissions occur shortly before the bag replacement.

More research needs to be conducted on the problems associated with in-stack cascade impactors and the problems and experiences of people using the impactors needs to be compiled and compared. Principle areas of further study should include: particle depositions in the impactor probe and body, weight losses of greased collection plates and anomalous weight gains of glass substrates. Also, the practicality of using impactors with stainless steel collection plates at low flow rates to reduce anomalous weight gains and losses without appreciable bounce problems should be studied. There is also a need for a combination of impactors to be used when performing a fractional efficiency/penetration type of evaluation on a control device which would allow simultaneous baghouse influent and effluent sampling thereby reducing the effect of temporal variations. Simultaneous sampling is especially desirable when sampling a cyclic process such as an electric arc furnace.

SECTION III

INTRODUCTION

BACKGROUND

The work reported in this publication represents one phase of a program whose purpose is to characterize the performance of several industrial size fabric filter systems. The fabric filter tested at the Marathon LeTourneau Company in Longview, Texas cleaned the emissions of either one or two 30-ton electric arc furnaces which produce a high strength, low-alloy specialty steel. Each furnace is fitted with a side draft hood and a canopy hood which is only used during charging and pouring. The hoods are ducted through a spark arrester to a 10-compartment American Air Filter baghouse which utilizes Dacron^{TM} bags.

APPROACH

The performance of the fabric filter was characterized by determination of the particulate removal efficiency as a function of total mass and particle size. In addition, the influent and effluent total fluoride concentrations were measured simultaneously with the particulate concentrations during three tests to qualitate the fluoride levels to which the filter bags are exposed during normal service. The apparent fractional efficiency, defined as the measured change in the particulate concentrations as a function of particle size that results from the filtration process, was determined by upstream and downstream sampling using inertial cascade impactors. The baghouse influent and effluent streams were also monitored with a condensation nuclei counter and an optical dust counter to determine variations in submicron particle concentrations as a function of the process and the cleaning cycle.

A pretest survey was performed primarily to determine the following: the sample time necessary for the outlet impactors to collect weighable samples, the presence and magnitude of impactor substrate anomalous weight gains, the mass removal efficiency of the filter papers used in the fluoride tests, the best diluter configurations for the baghouse inlet and outlet fine particle monitors, the variations in inlet mass concentration as a function of the process cycle, and the variability of baghouse operation and process cycle parameters. The tests in the major program were performed when there were either one or both furnaces in operation. Originally, it was planned to sample for 4 days with two furnaces in operation and 6 days with one furnace in operation. This plan was modified because of a change in the production schedule at the steel mill. The resulting testing program had only 2 test days with two furnaces but 8 test days with one furnace in operation. The greatest effect of having two furnaces in operation instead of one appears to have been than the inlet loading to the baghouse and hence the cloth loading rate was doubled. The change in the outlet concentration through the baghouse resulting from the increased inlet loading is an indication of whether the fabric filter's particle removal efficiency is dependent upon inlet loading.

SECTION IV

MARATHON LETOURNEAU STEEL MILL

The steel mill at Marathon LeTourneau produces high strength, low alloy, specialty steel in two electric arc furnaces of 30 tons each, nominal capacity. The furnaces are 10,000 kVA swing roof top charged units with individual combination side-draft and canopy hooding. The side-draft hoods operate while the furnace roof is in place and the canopy hoods operate when the roof is removed for charging and tapping. The furnaces use the basic steel making process with cold number one oil-free scrap. The furnaces must be back charged once to reach holding capacity, and the double slag method of refining is used. Additions of fluorspar are commonly made for slag conditioning and oxygen lancing is used to lower the carbon content of the melt.

The furnace hoods are ducted to a 10-compartment American Air Filter baghouse installed in 1973. Photographs of the baghouse are presented in Figures 1 and 2. The baghouse has a cloth area of 52,778 ft^2 which results in an air-to-cloth ratio of 3.22:1 at the design flow of 170,000 acfm at 150°F. The net air-to-cloth ratio increases to 3.58:1 with one compartment off-line for cleaning. The cleaning cycle is actuated by timer such that there is no delay time between cycles. The normal cleaning cycle schedule for each compartment is as follows:

Time, min.	Operation
0:00	Gas outlet damper closes
0:30	Bags begin shaking
1:00	Bags end shaking
1:40	Gas outlet damper opens
12:40	Next gas outlet damper closes

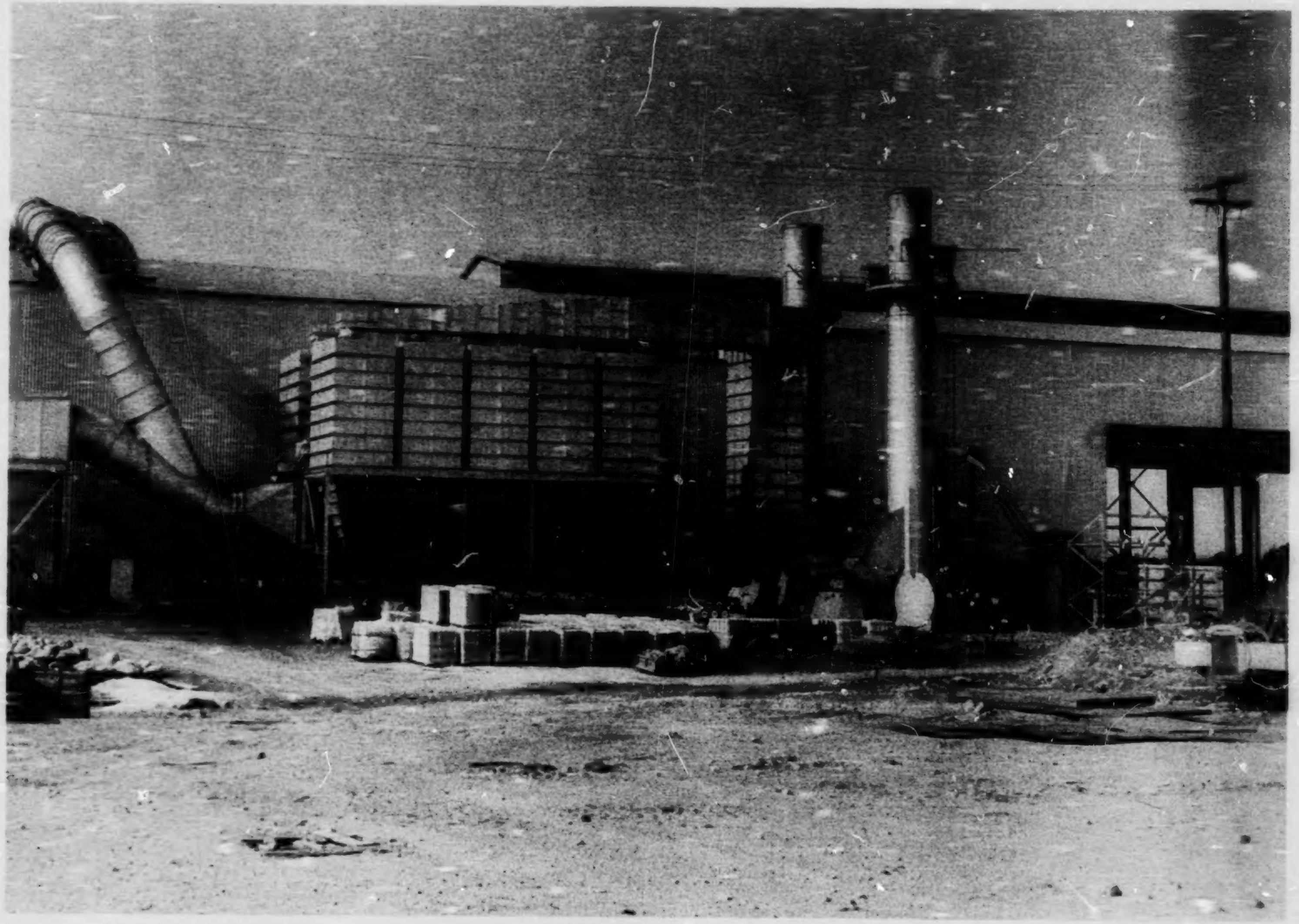


Figure 1. Photograph of side of fabric filter

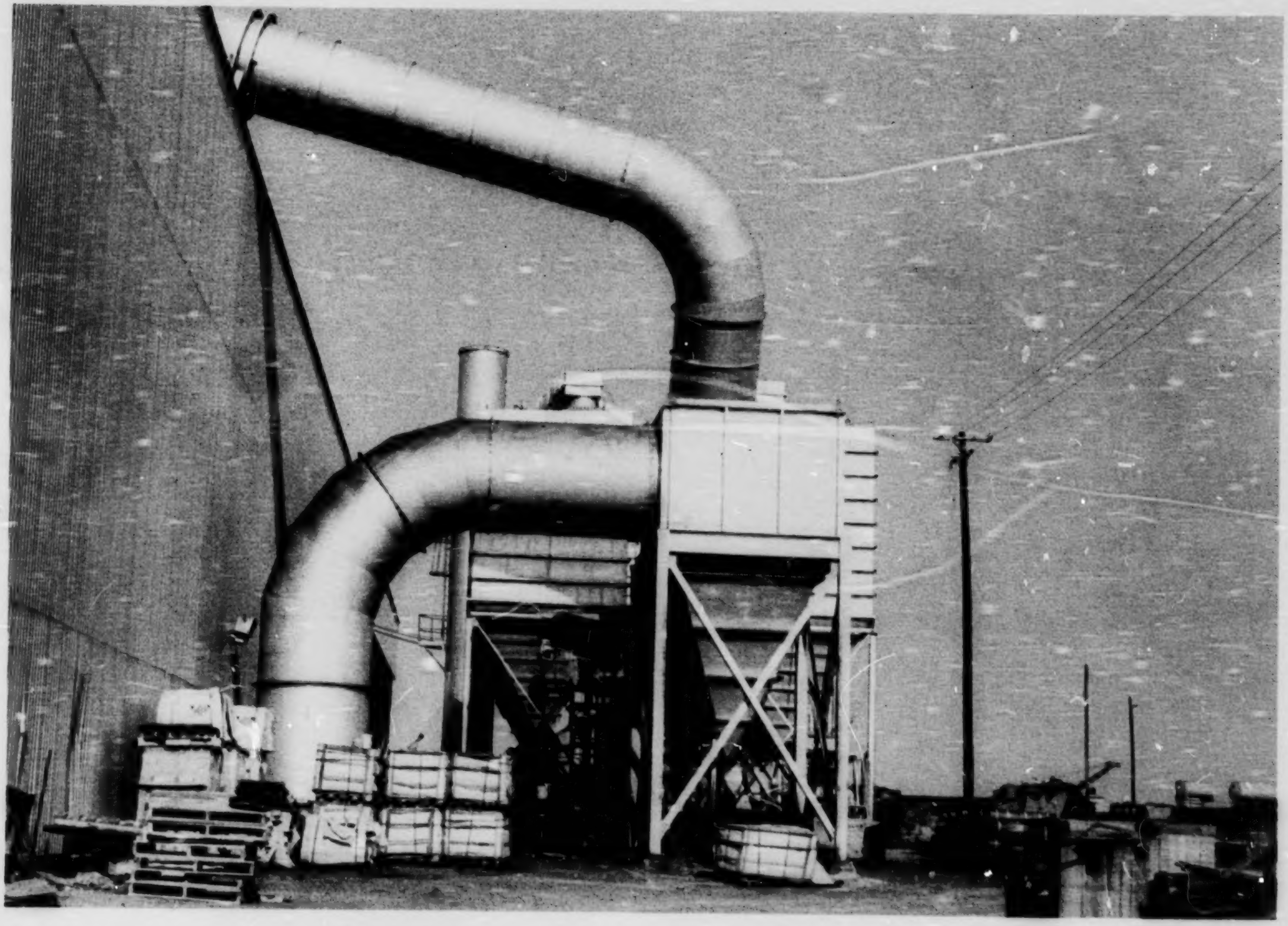


Figure 2. Photograph of end of fabric filter

Each baghouse compartment contains 288 Dacron^{TM} filter tubes which are 5 inches in diameter by 14 feet long. The filter tubes were fabricated by the Carborundum Company. The manufacturer's specifications for the filter material are as follows:

- Weight = 6.1 oz/yd^2
- Thread count = 79 x 89
- Weave = 3 x 1 twill
- Permeability at 0.5 in. H_2O = 15 to 25 cfm/ft^2

The results of the physical characterization tests performed on a new and used bag are presented in Table 1. The used bag tested was randomly selected from the bags removed from a compartment after about two years service. All the bags were replaced in the compartment because of difficulty locating a leaking bag. The physical characterization tests show that the air permeability of the used bag (~2 years service) is much less, 40 percent, than that for a new bag. The reduced air permeability or blinding of the fabric is most likely due to dust particles lodged in the fabric interstices. The tests also show that the breaking strenght and elongation has been reduced 15 to 20 percent indicating wear, however, bags which were not replaced are still in service after 3 years without breakage problems. It was also found that the used fabrics flexural rigidity was 43 percent higher than that of the new medium and is presumably due to particles in the intersticies of the fabric.

Table 1. RESULTS OF PHYSICAL CHARACTERIZATION TESTS ON FABRIC FILTER BAGS

Test description	New bag	Used bag[a]
ASTM D 1910, Sample weight,[b] oz/sq yd	6.23, 6.59	7.13, 7.37
ASTM D 1777, Sample thickness,[c] mils		
Range:	13.4 - 14.0	12.4 - 13.8
Average:	13.7	13.2
ASTM D 737, Air permeability,[c] cfm/sq ft at ½" H_2O ΔP		
Range:	19.7 - 27.2	9.2 - 10.2
Average:	24.2	9.8
ASTM D 1682, Breaking strength and elongation		
Breaking strength, lb		
Warp: Range:	225 - 234	189.1 - 193.5
Average:	229	191.6
Fill: Range:	149.1 - 172.4	117.8 - 148.1
Average:	160.6	127.3
Elongation at break, percent		
Warp: Range:	31.5 - 34.1	26.6 - 28.5
Average:	32.7	27.7
Fill: Range:	37.9 - 42.7	31.7 - 36.4
Average:	40.1	34.0
Flexural rigidity - beam method,[d] (10^{-4}) inch lb		
Warp:	3.32, 3.51	3.14, 3.75
Fill:	0.77, 0.85	1.58, 1.71
Average:	1.66	2.38
Adjusted for difference in mass		
Warp:		2.78, 3.31
Fill:		1.40, 1.51
Average:		2.10

[a] Bag in service for approximately 2 years, vacuumed prior to testing.

[b] Single measurements, sample area 6" x 6".

[c] Five tests each.

[d] Average of four tests, each reading (four up, four down).

SECTION V

EQUIPMENT AND METHODS

The baghouse filtering the effluent of the electric arc furnaces at the Marathon LeTourneau Company was evaluated for the total particulate penetration and the particulate penetration as a function of size. Total mass samples and size-classified samples for gravimetric analysis were collected before and after the fabric filter. The total mass samples from the first 3 test days were also analyzed for total fluorides. The influent and effluent of the baghouse were alternatively monitored for fine particulate with a condensation nuclei counter and an optical dust counter. Since most of the sampling methods were straightforward, they do not require extensive descriptions. Only the novel or unusual techniques will be described in detail.

MASS MEASUREMENTS

The baghouse influent and effluent mass concentrations were determined by sampling isokinetically utilizing a Research Appliance Company (RAC) Staksamplr.^{TM} The location of the baghouse inlet and outlet sampling ports and the points sampled are shown in Figures 3 and 4. Photographs of the inlet and outlet sampling locations are presented in Figures 5 and 6. The baghouse effluent is exhausted through two identical stacks and the north stack was arbitrarily chosen for testing purposes. Table 2 is a tabulation of the velocities measured in the inlet duct during the pretest survey. These velocities are fairly uniformly distributed in the duct. During the actual test series it was not possible to sample the bottom port (F) because of the height of the inlet platform and so to maintain symmetry, the top port (A) was also omitted. The inlet and

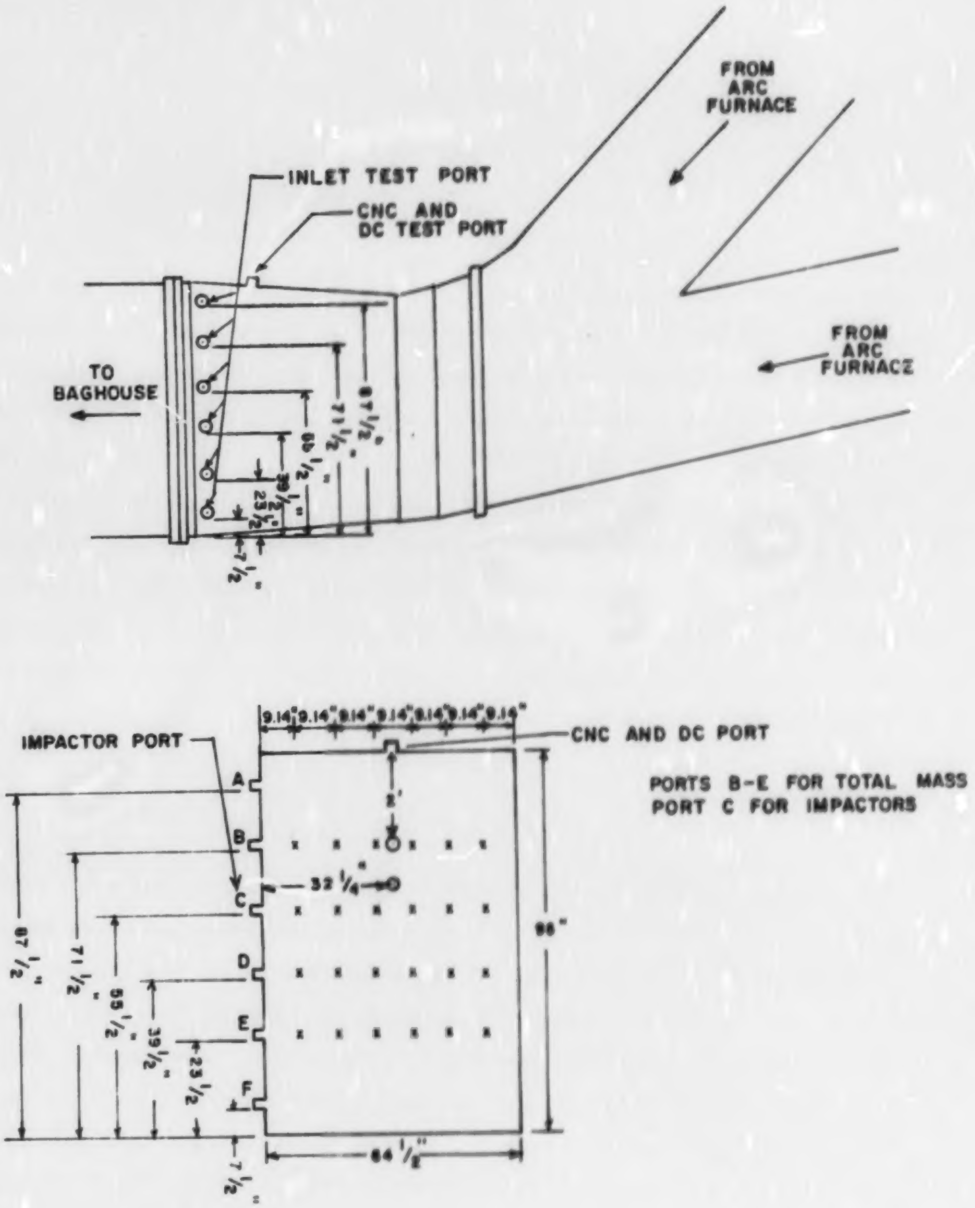


Figure 3. Location of baghouse inlet test ports and sampling points

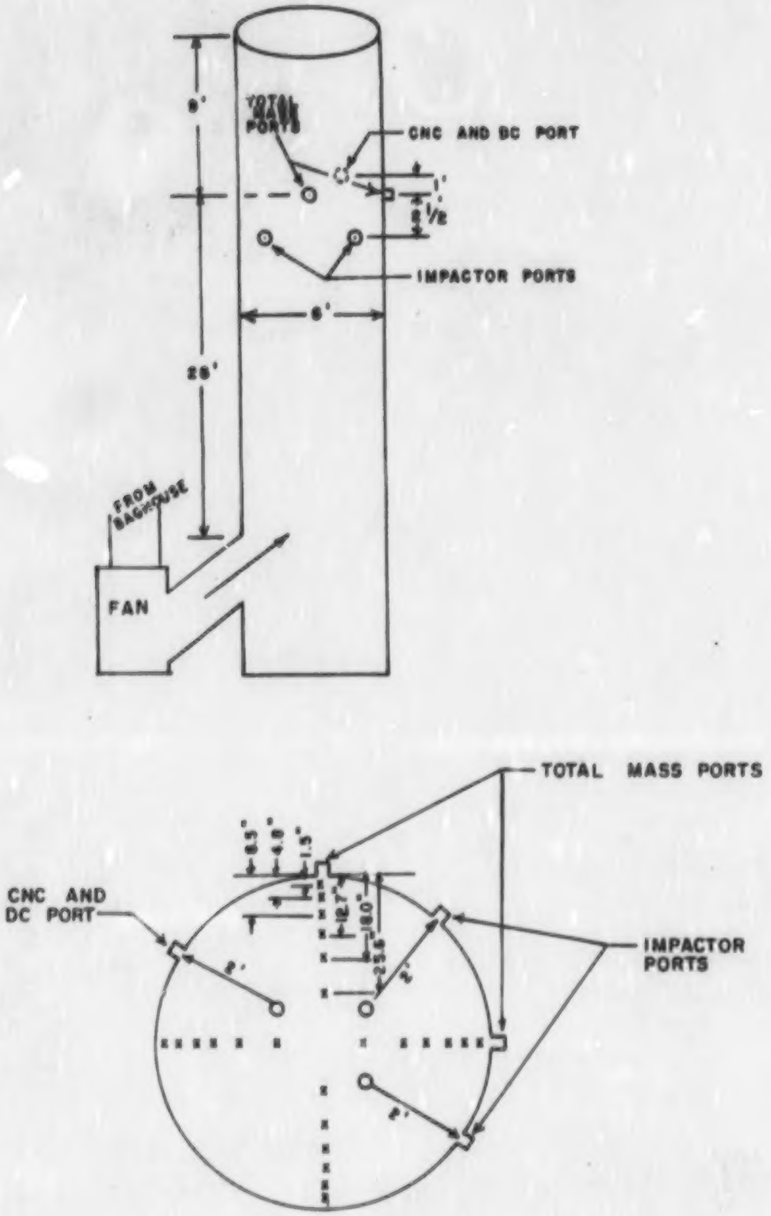


Figure 4. Location of baghouse outlet test ports and sampling points in north stack

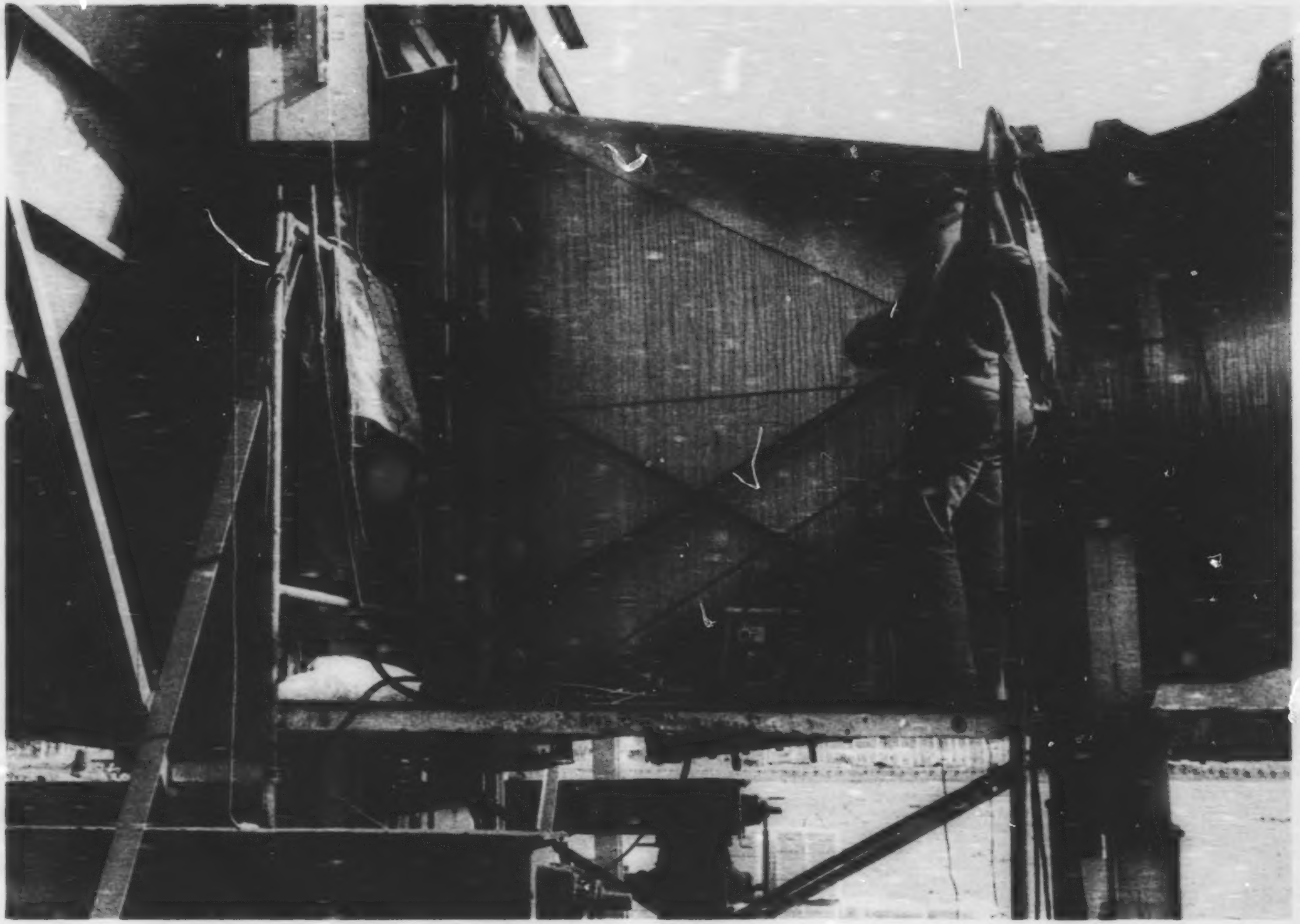


Figure 5. Photograph of inlet sampling location

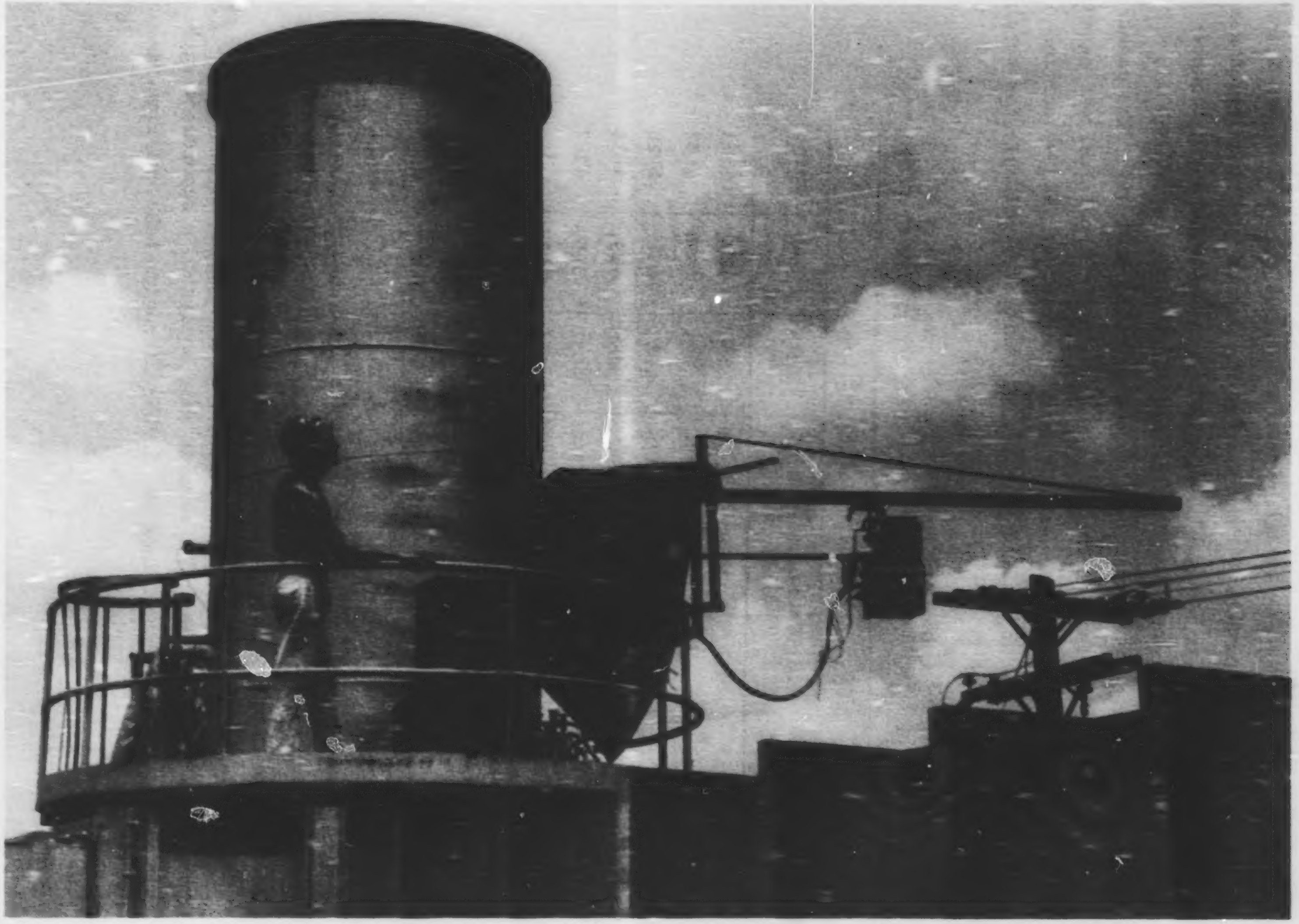


Figure 6. Photograph of outlet sampling location

outlet ducts were sampled simultaneous for 4 hours during test No. 1 and for 6 hours for tests Nos. 2 through 10. The 6-hour sampling period was selected because it encompassed approximately two complete arc furnace cycles. The filter media used for the total mass determinations was Whatman No. 1 filter, as required for the fluoride analysis. The penetration of particulate through the Whatman No. 1 cellulose filter was measured during the pretest survey to be less than 1 percent at face velocities comparable to those at the RAC filter and, therefore, suitable for total mass measurements.

Table 2. VELOCITIES IN FABRIC FILTER INLET DUCT

	Velocity, fpm					
Port	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
A	3281	3380	3800	4438	4287	4363
B	3341	4724	4928	4724	4654	4793
C	4287	4511	4438	4287	4511	4928
D	4363	4210	3969	3886	4131	4654
E	4131	4210	3969	4051	3969	4287
F	3713	4210	4051	4051	3713	4210

Note: Average velocity = 4207.

TOTAL FLUORIDES MEASUREMENTS

The baghouse influent and effluent samples collected in the total mass samplers during the first three tests were analyzed for total fluorides. Particulate samples from the probe wash, glass wash and filter and an aqueous sample from the impingers that capture gaseous fluorides were composited for analysis. The samples were analyzed in accordance with EPA Method 13A[2] which utilizes the SPADNS Zirconium Lake colorimetric method.

IMPACTOR MEASUREMENTS

The penetration of particles through the bag filter as a function of size and the inlet and outlet particle size distributions over the range of approximately 0.5 μm to 20 μm were determined using inertial impactors. The two types of impactors used were the Andersen Mark III Stack Sampler and the University of Washington (U of W) Mark III Source Test Cascade Impactor.

The lower four stages of each impactor used at Marathon LeTourneau were calibrated in the lab to determine the inertial impaction parameter at 50 percent efficiency in accordance with the procedure described by Calvert et al.[3] The calibration procedure consists of measuring the concentration of monodispersed polystyrene latex spheres with a Bausch and Lomb Dust Counter to determine the flow rate corresponding to 50 percent penetration of the particles. The flow rate for 50 percent penetration of the particles of known size is then used to calculate the inertial impaction parameter at 50 percent efficiency which is used to calculate the 50 percent particle size cutoff of a stage during sampling. The inertial impaction parameter for each impactor stage plus the pertinent impactor and particle parameters are presented in Table 3. Figure 7 presents the measured flow rates through the Andersen impactors for 50 percent penetration as a function of known size spheres. Figure 7 also has the manufacturer's curves for the Andersen impactor 50 percent cutpoints. The figure shows that equivalent impactor stages have similar size cutoffs, but these size cutoffs are smaller than indicated by the manufacturer for comparable flow rates.

The baghouse inlet stream was sampled several times during each test with the U of W impactor which collected the sample from the midpoint of port C as shown in Figure 3. The pipe supporting the impactor had a long radius bend allowing the impactor to be pointed directly into the stream, thereby eliminating the need for sampling through a gooseneck nozzle. The straight nozzle approach was employed to minimize probe losses. The influent

Table 3. IMPACTOR CALIBRATION PARAMETERS

		Impactor parameters			Particle parameters		
Impactor type	Impactor stage number	Number holes impactor stage	Stage jet diameter, cm	Impactor flow rate, cc/sec	Particle diameter, um	Particle density, g/cc	Inertial impaction parameter
Andersen 2000 INC	7A	156	0.0259	186.44	0.481	1.05	0.1739
Andersen 2000 INC	6A	264	0.0259	94.40	1.10	1.05	0.2325
Andersen 2000 INC	5A	264	0.0376	193.52	1.10	1.05	0.1558
Andersen 2000 INC	4A	264	0.0579	306.80	2.02	1.05	0.2143
Andersen 2000 INC	7B	156	0.0254	174.64	0.481	1.05	0.1727
Andersen 2000 INC	6B	264	0.0259	97.70	1.10	1.05	0.2406
Andersen 2000 INC	5B	264	0.0368	200.60	1.10	1.05	0.1722
Andersen 2000 INC	4B	264	0.0556	311.52	2.02	1.05	0.2458
University of Washington	7A	40	0.0356	101.48	0.600	1.05	0.2104
University of Washington	6A	110	0.0361	103.84	1.10	1.05	0.2267
University of Washington	5A	110	0.0528	125.08	2.02	1.05	0.2765
University of Washington	4A	90	0.0792	264.32	2.02	1.05	0.2116
University of Washington	7B	40	0.0333	96.76	0.600	1.05	0.2451
University of Washington	6B	110	0.0325	92.04	1.10	1.05	0.2754
University of Washington	5B	110	0.0498	106.20	2.02	1.05	0.2798
University of Washington	4B	90	0.0772	254.88	2.02	1.05	0.2204

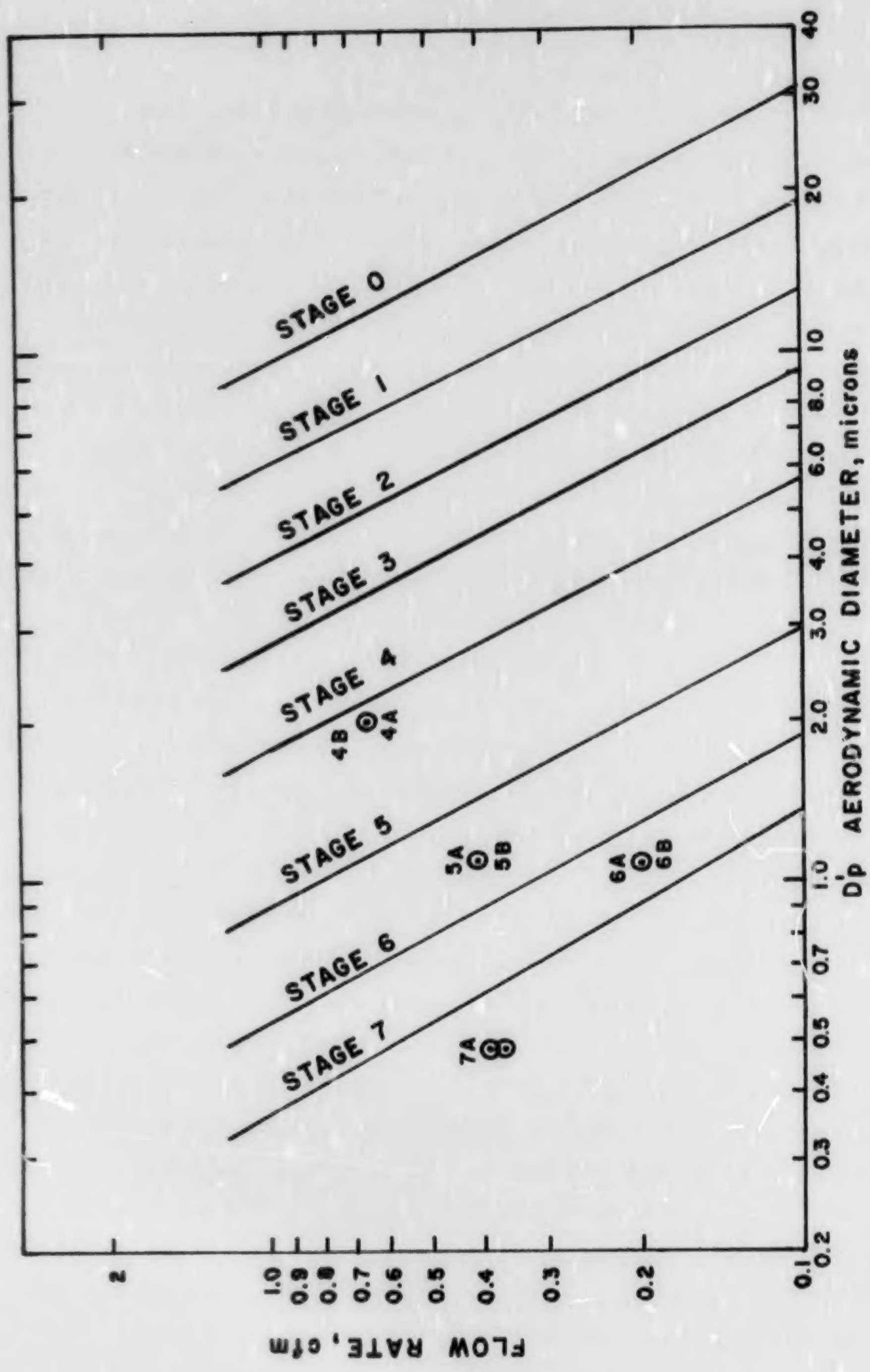


Figure 7. Andersen impactor manufacturer's curves and measured stage size cutoff points as a function of flow rate

impactor probe losses, which at times were considerable (20.00 to 51.04 percent) are presented in Table 4. These losses are believed to be larger particles which should have been collected on the upper impactor stages. Microscopic examination of resuspended dust removed from the baghouse hopper showed a population of large particles which could have accounted for the losses. The shape of the influent cumulative size distribution curves in Appendix A indicates that the larger particles were selectively removed in the probe. The affect of the probe losses is that the cumulative and differential size distribution curves in Appendix B are probably lower than actual for the larger particles. However, the actual size distribution of the particulate caught in the probe was not measured and this should be remembered when interpreting the impactor results.

During the first 4 testing days, the stainless steel inserts of the inlet impactor were coated with polyethylene glycol and dried for 2 to 3 hours at 300°F. It is not fully understood why some of the impactor inserts lost weight even though there were particles visible on the inserts. The weight loss problem was not anticipated because of the low temperature at the inlet of 130°F, the low flow rate of 0.3 acfm through the impactor and the short sampling time of 15 to 30 minutes. In tests 5 through 10, the inserts were not coated and weight loss was not a problem. While realizing the disadvantage of using uncoated inserts and the resulting increase in problems with particle bounce, it was believed that bounce would not be a serious problem at the low flow rate through the impactor. Inspection of the impactors after each sample was collected showed some evidence of bounce but the amount of particulate that was deposited on the bottom of the preceding jet stage was very small compared to the amount on the corresponding impaction surface. Therefore, sampling with uncoated inserts was considered to be better than with coated inserts when the problems associated with each were weighed.

The duration of inlet impactor sampling to collect a weighable sample on each stage without overloading was quite variable due to differences in the mass concentration as a function of the process cycle. After the

Table 4. PROBE LOSSES OF IMPACTORS SAMPLING THE FABRIC FILTER INFLUENT AND EFFLUENT

	Baghouse influent				Baghouse effluent
Test number	Impactor run A, percent	Impactor run B, percent	Impactor run C, percent	Impactor run D, percent	Impactor, percent
1	24.13				18.67
2	35.04	32.92			11.15
3	ND[a]	ND			17.65
4	ND	ND			10.43
5	ND	ND	34.85		28.78
6	31.54	27.45			25.00
7	24.75	20.00	28.68		17.12
8	49.06	44.74	25.35	51.04	23.78
9	25.28	24.91	22.19	20.63	12.73
10	48.41	50.69	41.67	36.80	18.62
INR[b]					9.88
2NR					14.95
3NR					12.56

[a] ND means no data due to impactor substrate weight loss problems.

[b] NR refers to an impactor run overnight.

first few tests, it was noticed that an increase of 0.2 to 0.4 in. Hg of meter static pressure caused by loading the impactor back up filter coincided with sufficient sample collection and was used in the remaining tests to determine the sampling duration.

The influent to the baghouse was sampled isokinetically by measuring the velocity, pressure and temperature at the impactor sampling point prior to sampling. The influent velocity, pressure and temperature were used with the other necessary parameters to calculate the pressure drop across the calibrated orifice necessary for isokinetic sampling. During sampling the flow through the impactor was kept constant.

The baghouse effluent was sampled for 9 hours during each test day with two instack Andersen cascade impactors in the locations shown in Figure 4. The outlet impactors sampled through straight nozzles so they could be pointed into the direction of flow to minimize probe losses. The resulting probe losses were from 9.88 percent to 28.78 percent and are included in Table 4. These probe losses were much less than the influent impactor probe losses and are considered to have only a minimal effect on the cumulative and differential size distribution curves. Reeve Angel 934 AH type glass filter substrates were used in the impactors because they have been found to be less reactive with stack gases than the Gelman Type A glass fiber filters.[4] Two impactors were run simultaneously during each testing day with one of the impactors sampling filtered flue gas to indicate any anomalous weight gains. The figures in Appendix C show the suspected anomalous weight gains for each stage of the impactor sampling flue gas and the corresponding stage of the impactor sampling filtered flue gas during the 10 test days. Examination of the figures in Appendix C indicates considerable weight gain in a number of cases and in a few cases the weight gain of the impactor stage sampling filtered flue gas was greater than that of the impactor sampling unfiltered flue gas. In only one case was there no apparent anomalous weight gain. It is most difficult to quantify the apparent anomalous weight gain because it did not follow a pattern with respect to amount of weight gained by any particular stage.

Since a systematic error was not apparent and since the outlet differential distributions in Appendix B do not appear to be dependent upon the apparent anomalous weight gain, no corrections were made to the weight gained by the substrates of the impactor sampling unfiltered effluent.

In addition to the impactors run during each normal test day, there were three sets of outlet impactors run from 13 to 15 hours overnight. These impactors were run as an experiment to see if cascade impactors could be run unattended. Running the impactors unattended seemed to be a success with the flow in the morning being the same as that set the preceding evening. The overnight impactors were also run in pairs with one sampling prefiltered flue gas. These impactors, however, utilized Gelman Type A glass filter substrates. The apparent anomalous weight gain for the night runs, also shown in Appendix C, appears to be higher than during most of the day runs in which the Reeve Angel substrates were used.

A comparison was made among the outlet mass concentrations measured by the RAC Staksamplr^{TM}, which is considered to be the true concentration in the duct, the mass concentration measured by the impactor and the mass concentration measured by the prefilter on the blank impactor. This comparison is presented graphically in Figure 8 and includes the line that would result from perfect correlation and the actual line of best fit. It can be seen that the impactor measurements consistently indicate a lower concentration than the RAC train. This may be caused by the fact that the impactors sampled at single points in the duct while the RAC train traversed many points, or it may indicate an inherent inconsistency between the measurement methods. The lower mass concentration measured by the impactors would appear to be contraindicative of serious anomalous weight gain problems as observed in another similar comparison.[5]

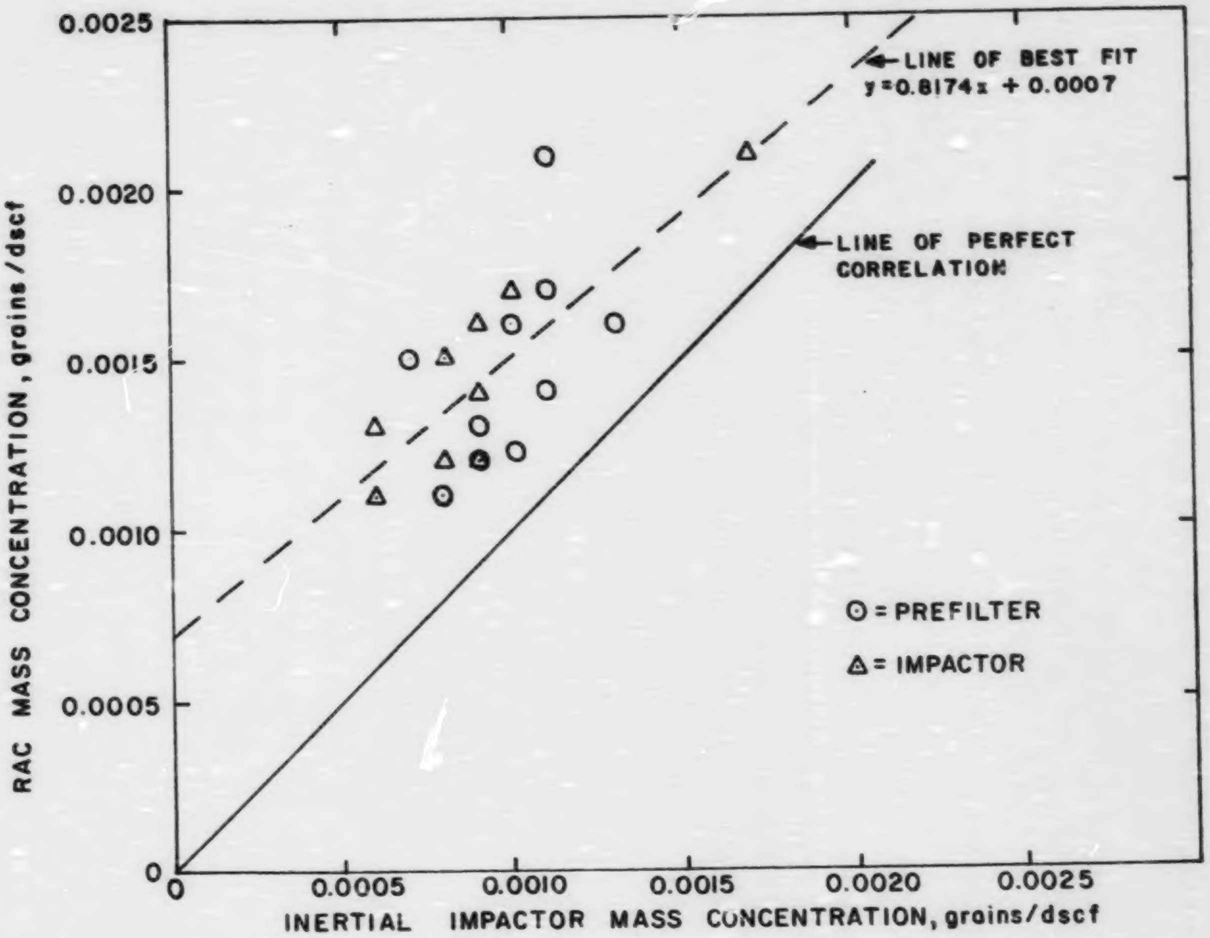


Figure 8. Correlation between the outlet mass concentrations determined by the RAC stack sampler and the inertial impactor and prefilter

FINE PARTICULATE MEASUREMENTS

The penetration of fine particles through the fabric filter was determined by sampling the baghouse influent and effluent streams with a Dust Counter (DC) and a Condensation Nuclei Counter (CNC) with a Diffusion Denuder (DD). The particle concentrations were measured by a Bausch and Lomb 40-1 DC and by a Rich Model 100 CNC. Particle sizing was accomplished directly with the DC and the CNC utilizing the DD. The DC has seven size ranges with the following smallest detectable particle sizes: 0.3 μm, 0.5 μm, 1.0 μm, 2.0 μm, 3.0 μm, 5.0 μm and 10 μm. The CNC measures particles of 0.0025 μm and larger diameter[6] in the concentration range of 1,000 to 300,000 particles/cc. The theoretical upper size limit measurable by the CNC has been estimated to be 0.3 to 0.5 μm.[7]

Sizing with the CNC and DD is accomplished by drawing the sample through the DD where particles less than a particular size, dependent upon the flow rates, are removed. The CNC then measures the concentration of the particles remaining. The five DD flow rates utilized at Marathon LeToruneau resulted in the removal of all particles over the range of less than 0.014 μm at the highest flow rate and less than 0.078 μm at the lowest flow rate.

The temperature and moisture content of the influent and effluent of the baghouse were in a range to allow sampling without dilution. Dilution was not necessary at the outlet and the sample was extracted through a stainless steel probe, and tygon tubing to a "Y" where part of the sample went to the CNC and part to the DC. When the DD was used, it was inserted between the "Y" and the CNC.

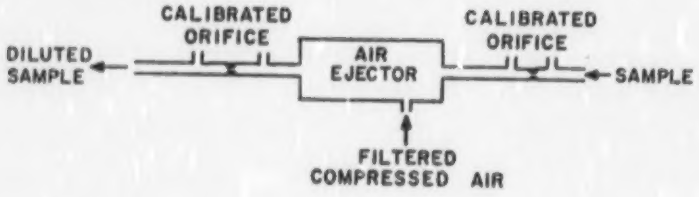
Dilution of the sample was required at the inlet because of the high static pressure in the duct and the high concentration of fine particles. A two-stage dilution was effected utilizing two basic diluter designs. A sample of the flue gas was extracted through a stainless steel probe and through the air ejector diluter shown in Figure 9(a). A portion of the diluted sample from the air ejectro diluter was then drawn through a capillary tube diluter, Figure 9(b), to a "Y" where the sample flow split with part going to the CNC and part to the DC. When the DD was used, it was inserted between the "Y" and the CNC as on the outlet.

The air ejector diluter is limited to a maximum dilution of approximately 90 to 1. Its main value is its ability to extract a sample from a low pressure location and to discharge the diluted sample at about atmospheric pressure. The CNC and DC will not operate properly when the pressure of the sample entering the CNC or DC is too far below atmospheric, ~2 in. H_2O. In the air ejector diluter, the sample is drawn through an orifice by an air ejector in which the sample stream and a filtered compressed air stream are mixed before being discharged through an orifice which meters the combined flow.

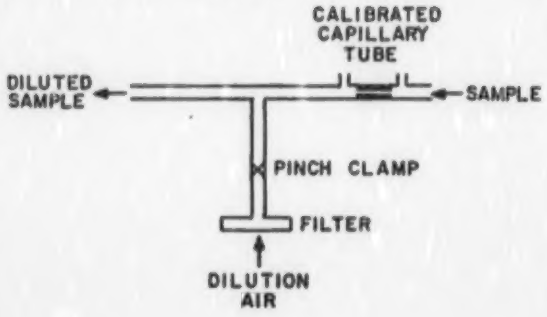
The capillary tube diluter is capable of providing a 12 to 1 dilution. A capillary tube meters the sample flow which is combined with regulated filtered dilution air in a tee. The combined sample and dilution flow is equal to the flows through the CNC and DC. The capillary tube diluter was also used to vary the sample flow rates through the DD to provide sizing data. In this case, the combined sample and dilution flow is equal to the flow through the CNC.

The DD is made of three closely spaced (0.097 cm) concentric cylinders on which diffused particles are collected. The d_{50}, which is the particle diameter removed in the DD with 50 percent efficiency, is dependent upon the flow rate through the DD. The DD is most applicable for particle sizes ranging from 0.01 to 1 μm diameter.[6]

Particle sizing was accomplished by first sampling with the CNC alone which corresponded to particles $\geq$ 0.0025 μm. Next, flows varying from approximately 2 cc/sec to 50 cc/sec were passed through the DD. The



(A) AIR EJECTOR DILUTER



(B) CAPILLARY TUBE DILUTER

Figure 9. Fine particle dilution system components

approximate flows and resulting DD size cutoffs were 2 cc/sec and 0.078 μm, 5 cc/sec and 0.048 μm, 10 cc/sec and 0.034 μm, 25 cc/sec and 0.021 μm, and 50 cc/sec and 0.014 μm.

SECTION VI

RESULTS

The primary purpose of the sampling program at Marathon LeTourneau was to define the total and fractional particulate penetration through a fabric filter cleaning the emissions from an electric arc furnace. The secondary reasons for testing were to determine the effect of approximately doubling the particulate loading to the baghouse on the total and fractional penetration and to measure the influent and effluent total fluoride concentrations to estimate the levels to which the Dacron^{TM} filter bags are exposed during normal service. In addition, the baghouse inlet and outlet submicrometer particle concentrations were measured as a function of the process cycle and the baghouse cleaning cycle to determine if periods of high penetration are a function of the process cycle, the cleaning cycle or both. Finally, the inlet particle size distributions were measured as a function of the process cycle.

TOTAL MASS MEASUREMENTS

The baghouse inlet and outlet particulate mass concentrations for the 3 pretest survey testing days and for the 10 regular testing days are presented in Table 5. These concentrations were measured with total mass samplers, impactors (without prefilters) and an impactor prefilter.

The data summary sheets with measured parameters and the calculated results for the total mass and impactor samples are presented in Appendixes D and E, respectively. The properties of the baghouse influent and effluent flue

Table 5. RESULTS OF PARTICULATE SAMPLING AT MARATHON LETOURNEAU

Test day	No. furnaces in operation	Pressure drop across compartment No. 6, in. H_2O	Face velocity, ft/min	Baghouse inlet; concentration, grains/dscf					Baghouse outlet, north stack; concentration, grains/dscf			Fabric filter mass penetration,[a] percent
				Total mass sampler	Impactor run A	Impactor run B	Impactor run C	Impactor run D	Total mass sampler	Impactor prefilter	Impactor A	
1[b]	1	-	3.32	0.0627[c]	0.0579[d]	-	-	-	-	0.0018[d]	0.0022[d]	-
2[b]	1	-	3.48	0.0804	0.0414[d]	0.0903[d]	-		0.0019	0.00036[d]	0.00025[d]	2.3632
3[b]	-	-	-	-	-	-	-	-	-	0.0007[d]	-	-
1	2	-	3.39	0.1506	1.9185[e]	0.0594[e]	-	-	0.0017	0.0011[d]	0.0010[d]	1.1288
2	2	-	3.58	0.1438	0.0765[e]	0.0911[e]	-	-	0.0021	0.0011[d]	0.0011[d]	1.4604
3	1	3.50	3.37	0.0603	-	-	-	-	0.0012	0.0010[d]	0.0009[d]	1.9900
4	1	-	3.34	0.0729	-	-	-	-	0.0016	0.0010[d]	0.0009[d]	2.1948
5	1	3.40	3.35	0.0650	-	-	0.0500[e]	-	0.0015	0.0007[d]	0.0008[d]	2.3077
6	1	3.40	3.41	0.0672	0.0369[e]	0.0287[e]	-	-	0.0013	0.0009[d]	0.0006[d]	1.9345
7	1	3.24	3.36	0.0675	0.0664[e]	0.1022[e]	0.0947[e]	-	0.0011	0.0008[d]	0.0006[d]	1.6296
8	1	3.12	3.56	0.0736	0.0594[e]	0.0538[e]	0.0485[e]	0.0368[e]	0.0016	0.0013[d]	0.0009[d]	2.1739
9	1	3.35	3.43	0.0615	0.0682[e]	0.0533[e]	0.1286[e]	0.1443[e]	0.0014	0.0011[d]	0.0009[d]	2.2764
10	1	3.34	3.42	0.0617[f]	0.0571[e]	0.0497[e]	0.0856[e]	0.0868[e]	0.0012	0.0009[d]	0.0008[d]	1.9449
6[g]	-	-	-	-	-	-	-	-	-	0.0007[d]	0.0007[d]	-
8[g]	-	-	-	-	-	-	-	-	-	0.0008[d]	0.0005[d]	-
9[g]	-	-	-	-	-	-	-	-	-	0.0009[d]	0.0008[d]	-

[a] Calculated from the inlet and outlet total mass concentrations.

[b] Pretest survey.

[c] Evidence of particulate leakage around the filter indicating that the reported mass concentration may be lower than the actual mass concentration.

[d] Andersen impactor.

[e] University of Washington impactor.

[f] Sample was inadvertently extracted nonisokineticcally.

[g] Impactors run overnight.

gas are presented in Table 6. The penetrations which are included in in Table 5 were calculated from the inlet and outlet total mass concentrations.

Examination of Table 5 shows that the inlet concentrations for the test days during which there were two furnaces in operation were approximately twice that of the runs in which there was only one furnace in operation. The table also shows wide variations in inlet concentration measured by the inlet impactors as a result of these samples being collected at various points in the process cycle. The variation in concentration over a process cycle was measured during the pretest survey by taking a series of total mass samples in succession over the cycle. It was found that the inlet concentration varied by a factor of 2.5 with the alloy addition phase being the period of maximum concentration and the tap being the period of minimum concentration as shown in Figure 10.

The mass penetration and the total mass sample outlet concentration statistics for the entire series of tests, for the subseries of tests with two furnaces in operation and for the subseries of tests with one furnace in operation are presented in Table 7. These statistics show that the penetration is lower even though the outlet concentration is higher (40 percent) with the two furnaces in operation indicating the baghouse particulate removal efficiency varies with inlet grain loading. Thus the baghouse dampens changes in the outlet concentration or emission rate caused by variations in the inlet concentration.

Table 7. OUTLET CONCENTRATION AND PENETRATION STATISTICS

	Penetration, %		Outlet concentration, grains, dscf	
Tests	Mean	Standard deviation	Mean	Standard deviation
All	1.904	0.3862	0.0015	0.0003
With 2 furnaces on	1.295	0.2345	0.0019	0.0003
With 1 furnace on	2.056	0.2263	0.0014	0.0002

Table 6. FLUE GAS PROPERTIES

Test No.	No. Furnaces in operation	Influent			Effluent (North Stack)			
		Volumetric flow rate, dscfm	Avg. gas temp, °F	Moisture, percent	Volumetric flow rate, dscfm	Avg. gas temp, °F	Moisture. percent	Particulate emission rate, lb./hr
1	2	164,406	107	1.31	67,046	120	2.22	0.994
2	2	166,623	131	1.42	66,208	130	1.47	1.220
3	1	154,056	140	1.51	66,558	132	1.55	0.664
4	1	153,606	128	2.51	65,942	126	1.53	0.930
5	1	152,550	132	2.65	67,684	131	1.99	0.848
6	1	154,066	134	3.19	66,523	129	1.85	0.737
7	1	154,311	130	2.28	66,692	125	2.15	0.642
8	1	166,142	127	1.89	72,089	128	2.43	0.995
9	1	151,374	155	2.32	67,658	133	2.46	0.830
10	1	157,354	134	1.56	66,659	130	2.10	0.676

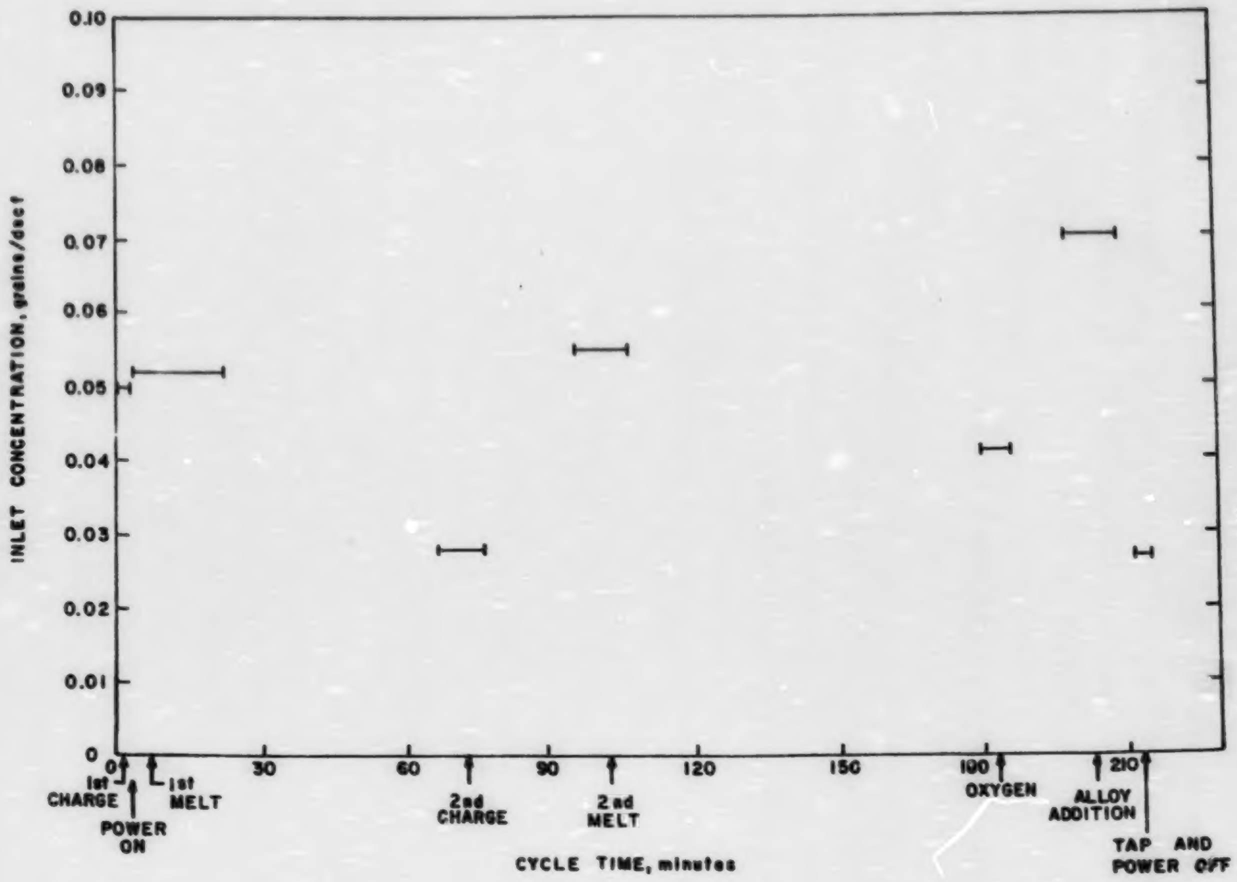


Figure 10. Inlet concentration as a function of events in the process cycle

IMPACTOR MEASUREMENTS

The task of determining the average or representative inlet particulate cumulative and differential size distributions is difficult because it cannot be measured directly. A direct measurement of size distribution is impossible because a process cycle lasts approximately 3 hours and the in-stack impactors which measure the size distributions were limited to about 15 minutes sampling duration due to the high inlet mass concentration causing overloading of impactor stages. The problem was attacked by making individual measurements at various points in the process with samples taken during the major events of the process cycle. Figure 11 shows the time in the process cycle over which each of the inlet impactor samples was collected during each test day and also indicates the frequency of sample collection during the entire testing program. It shows that the inlet was sampled for nearly every minute of the process cycle over the testing sequence. Since it was impossible to collect an ideal inlet sample, it was necessary to composite several typical or average differential size distributions to enable calculation of the fractional penetration. The construction of a representative inlet size distribution would be further supported if day-to-day variations were not observed. Although this is not the case, the compositing of several runs appears to be the best approach. Figure 12 presents the measured mass median diameter (MMD's) as a function of the process cycle and testing day. From Figure 12 it is clear that variations in MMD's did occur on a daily basis and were most pronounced immediately before the slag-off part of the cycle. Figure 13 (a through d) shows the differential size distribution curves for different test days for the sample collected during the first melt, back charge, second melt, and tap. These curves show that there was considerable variation in the differential size distribution on a daily basis. The next step in constructing a composite inlet curve was to average the curves for each part of the process. These curves are also presented in Figure 13 (a through d). These average curves were then weighted with respect to the time portion represented by their individual

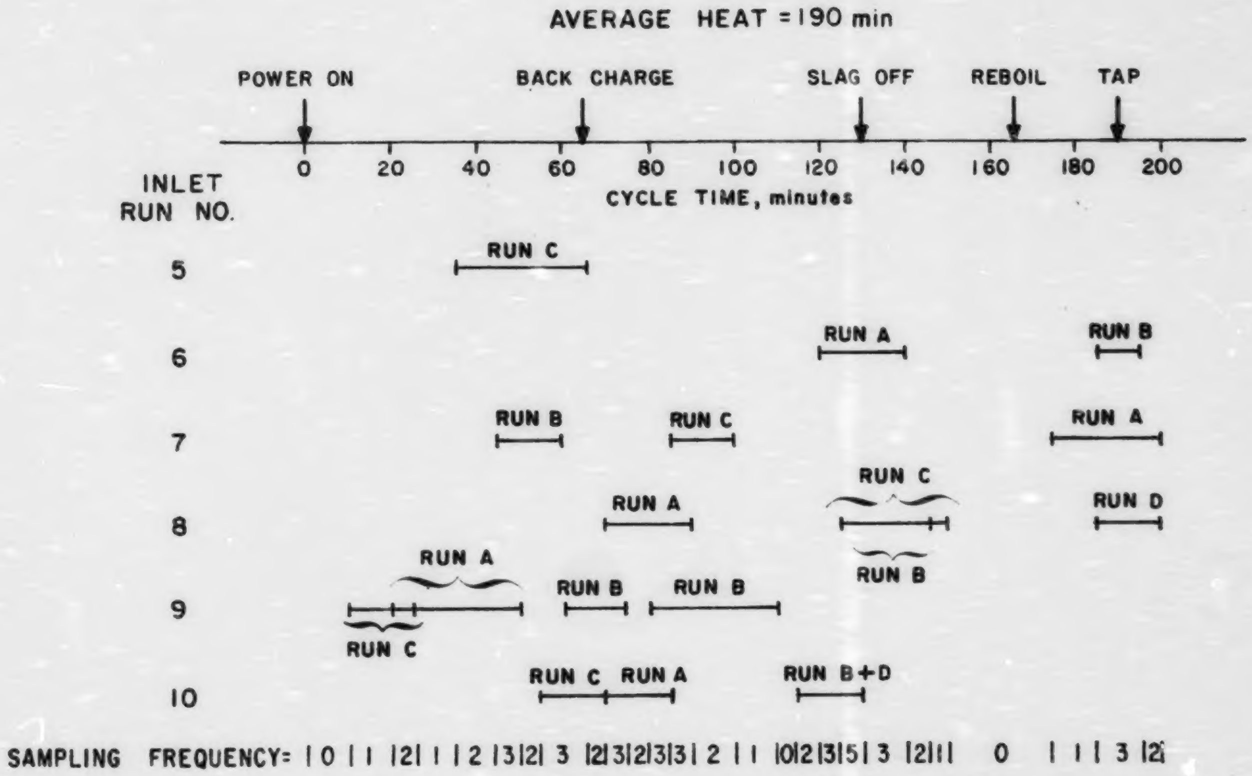


Figure 11. Time in process cycle at which inlet samples were collected

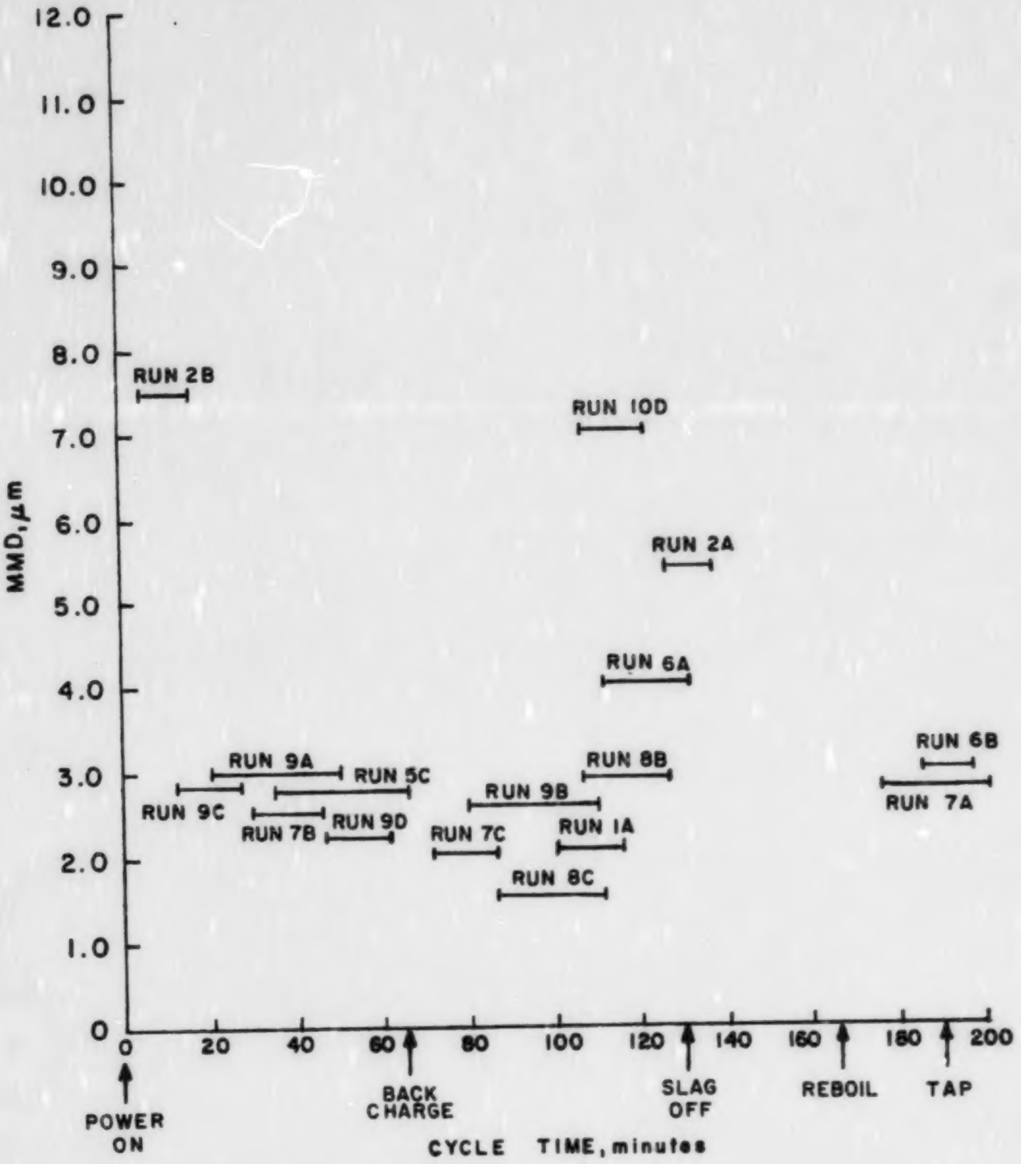


Figure 12. Inlet MMD as a function of process cycle and testing day

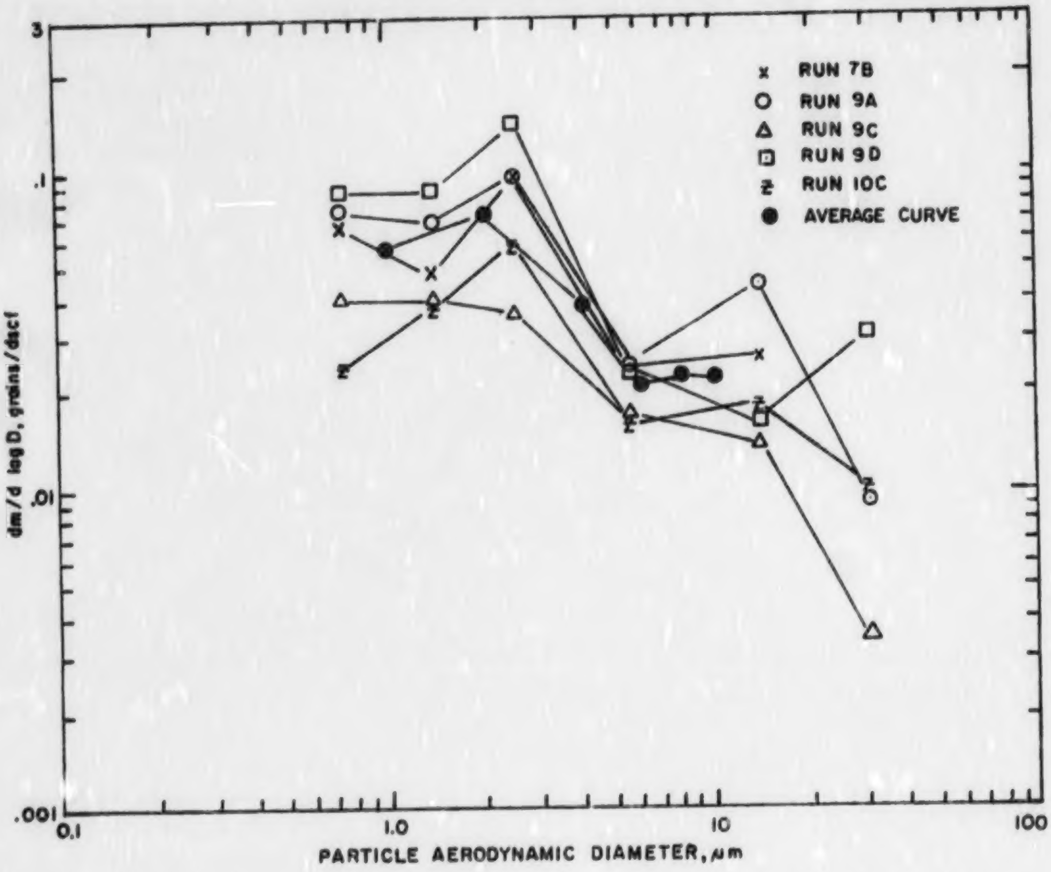


Figure 13a. Differential size distribution curves of baghouse inlet aerosol during first melt phase of process cycle when one electric arc furnace is operating

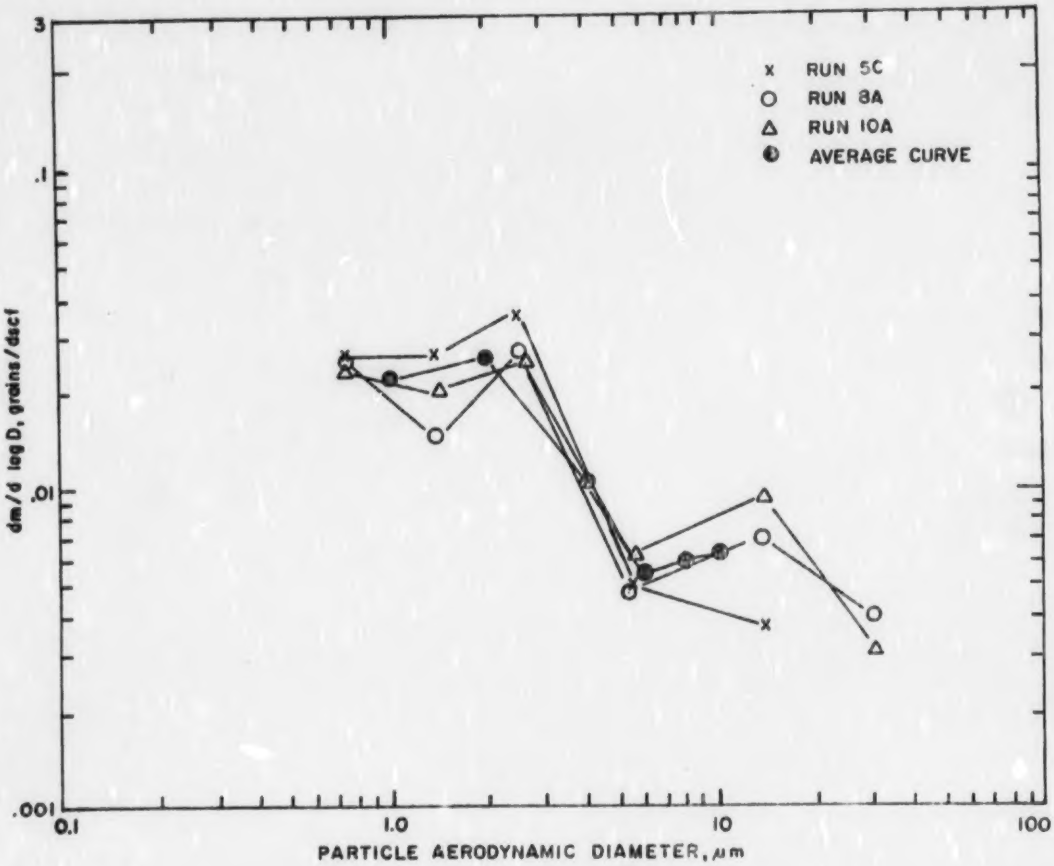


Figure 13b. Differential size distribution curves of baghouse inlet aerosol during back charge phase of process cycle when one electric arc furnace is operating

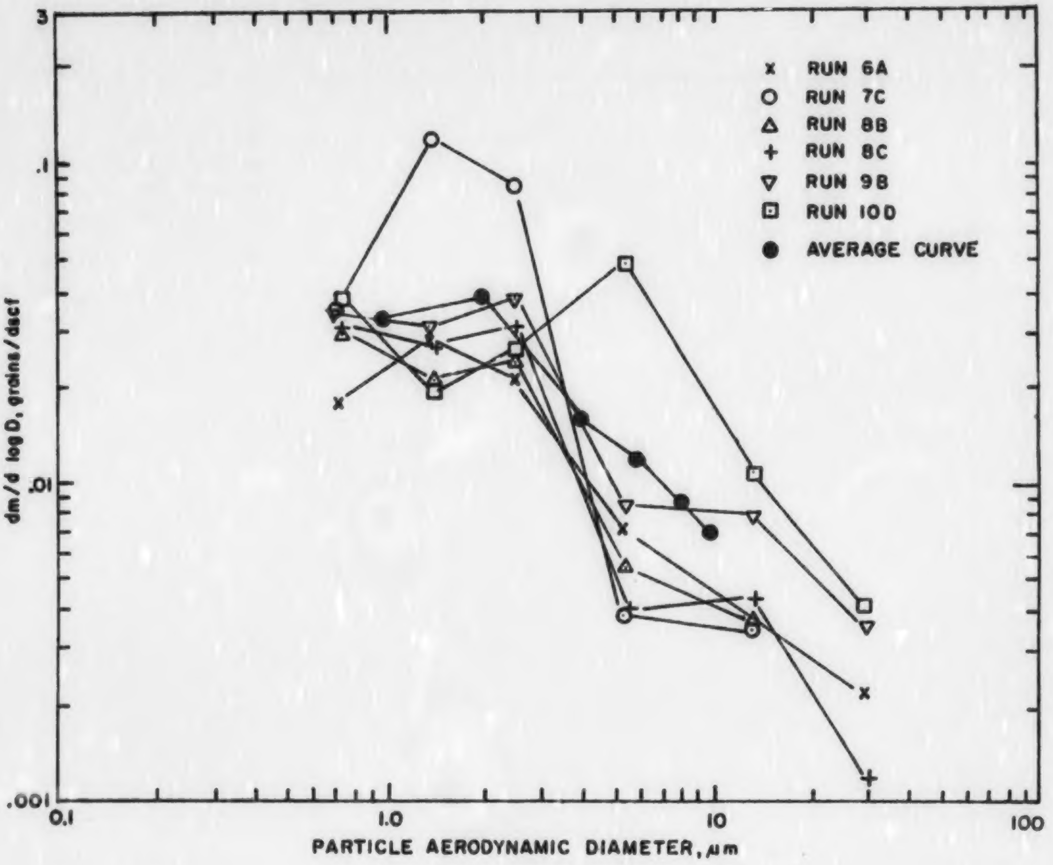


Figure 13c. Differential size distribution curves of baghouse inlet aerosol during second melt phase of process cycle when one electric arc furnace is operating

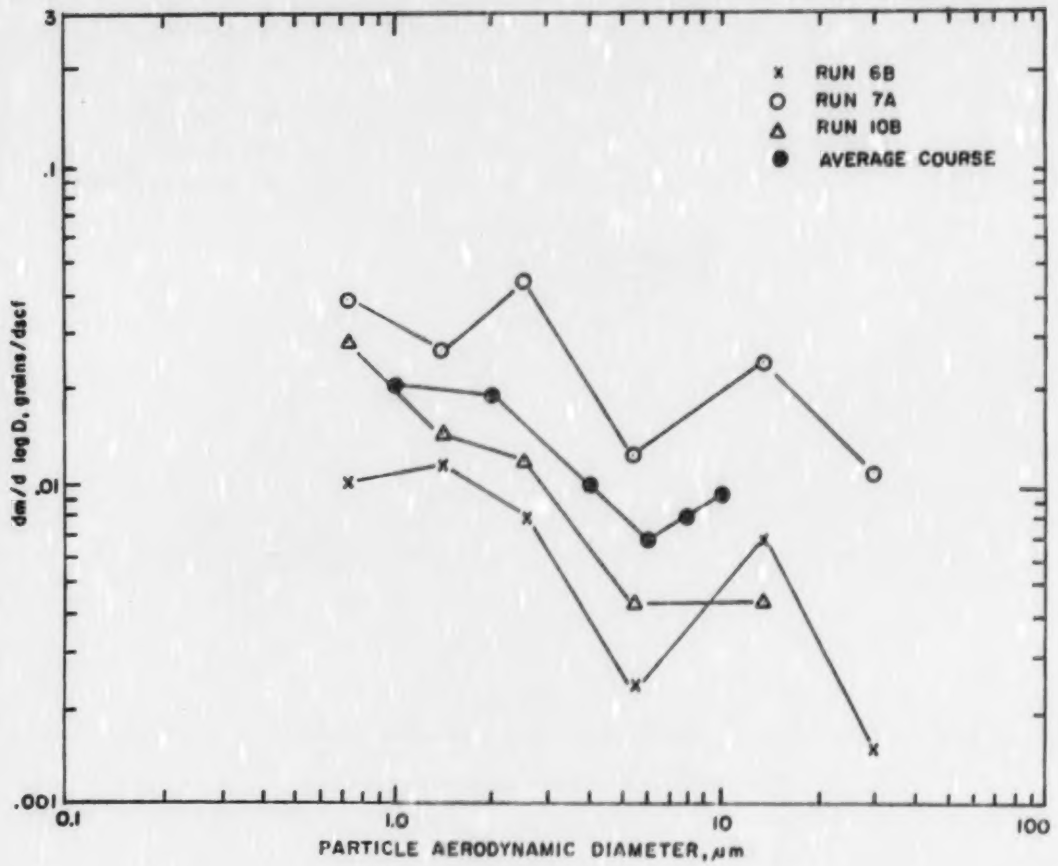


Figure 13d. Differential size distribution curves of baghouse inlet aerosol during tap phase of process cycle when one electric arc furnace is operating

part of the cycle to the complete cycle. The composite inlet curves for one and two furnaces in operation are presented in Figure 14. The composite inlet differential distribution curve for two furnaces in operation was calculated by multiplying the composite inlet curve for one furnace operation by the ratio of the average inlet concentration measured by the inlet total mass sampler during two furnace operation to that average concentration measured during one furnace operation. The average differential distribution curves in Figure 13 (a through d) were also used to determine the differential concentrations for 1, 2, 4, 6, 8, and 10 μm particles as a function of the process cycle. These curves are presented in Figure 15 (a through f). These curves show the first melt to have the highest concentration for all particle sizes and the back charge and the tap phases to have the lowest concentrations for most sizes.

The composited inlet differential size distribution curves were then used with the averaged outlet differential distribution curves for one and two furnace operation (Figure 16) to calculate their respective fractional penetration curves presented in Figure 17. A comparison of the inlet and outlet differential size distributions (Figures 14 and 16) shows the curves to have somewhat similar shapes with a slightly larger outlet particle size (4 μm outlet and 2 μm inlet) having the maximum concentration. The similarity in curve shape indicates that some of the influent aerosol is passing through the baghouse without capture and would suggest bag leakage during sampling. The shapes of the fractional penetration curves are unusual in that they show the 1.0 μm particles to have the least penetration while the 6.0 μm particles have the greatest penetration. These shapes would not be predicted by fabric filtration theory. The lower penetration of smaller particles as well as the higher penetration of the larger ones indicates agglomeration of the smaller particles. The agglomerates in the effluent are believed to result mainly from fabric rear face dislodgment of collected particles.

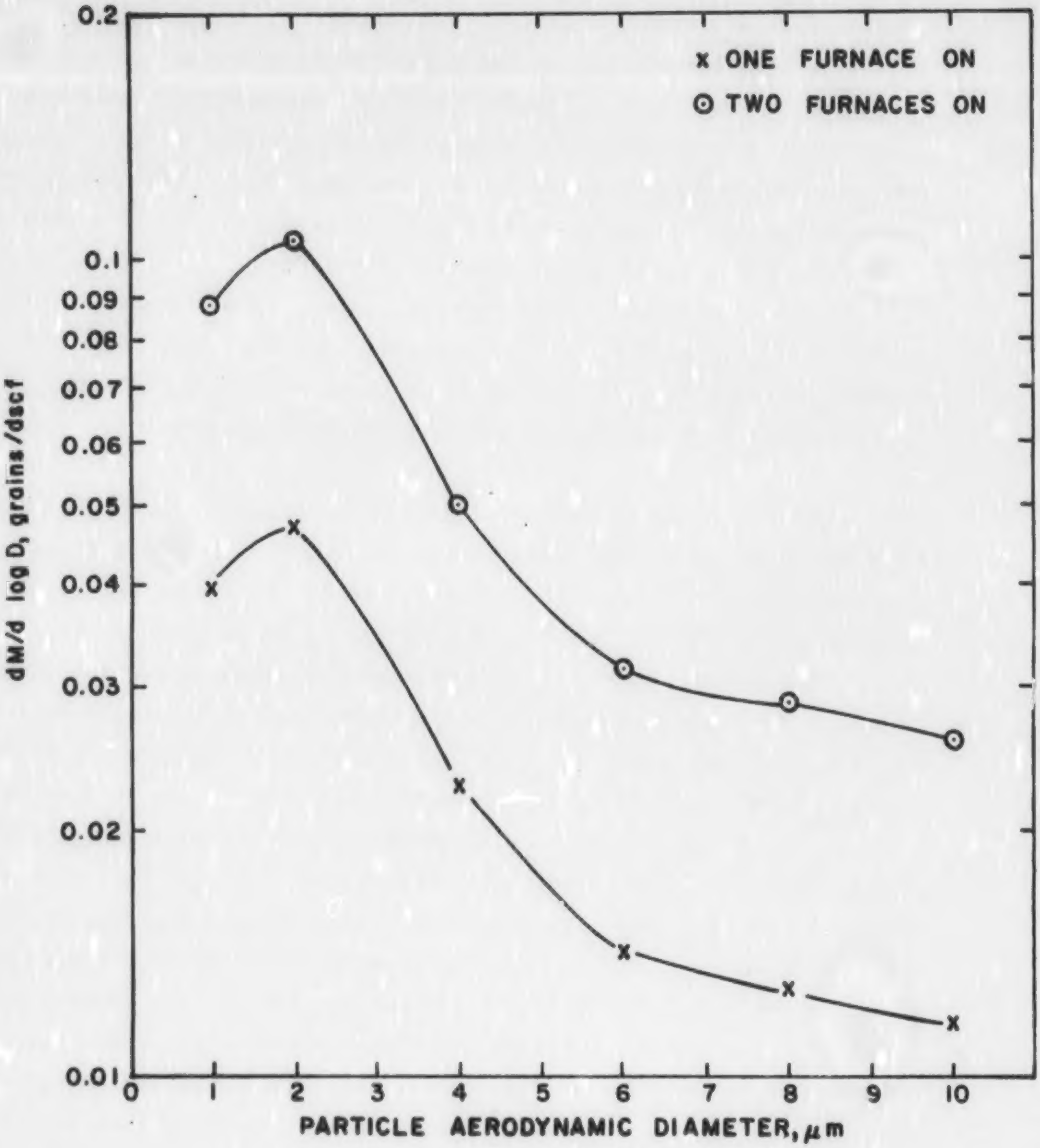


Figure 14. Composited differential size distribution curves of baghouse inlet aerosol for a process cycle with one and two furnaces operating (190-minute furnace cycle)

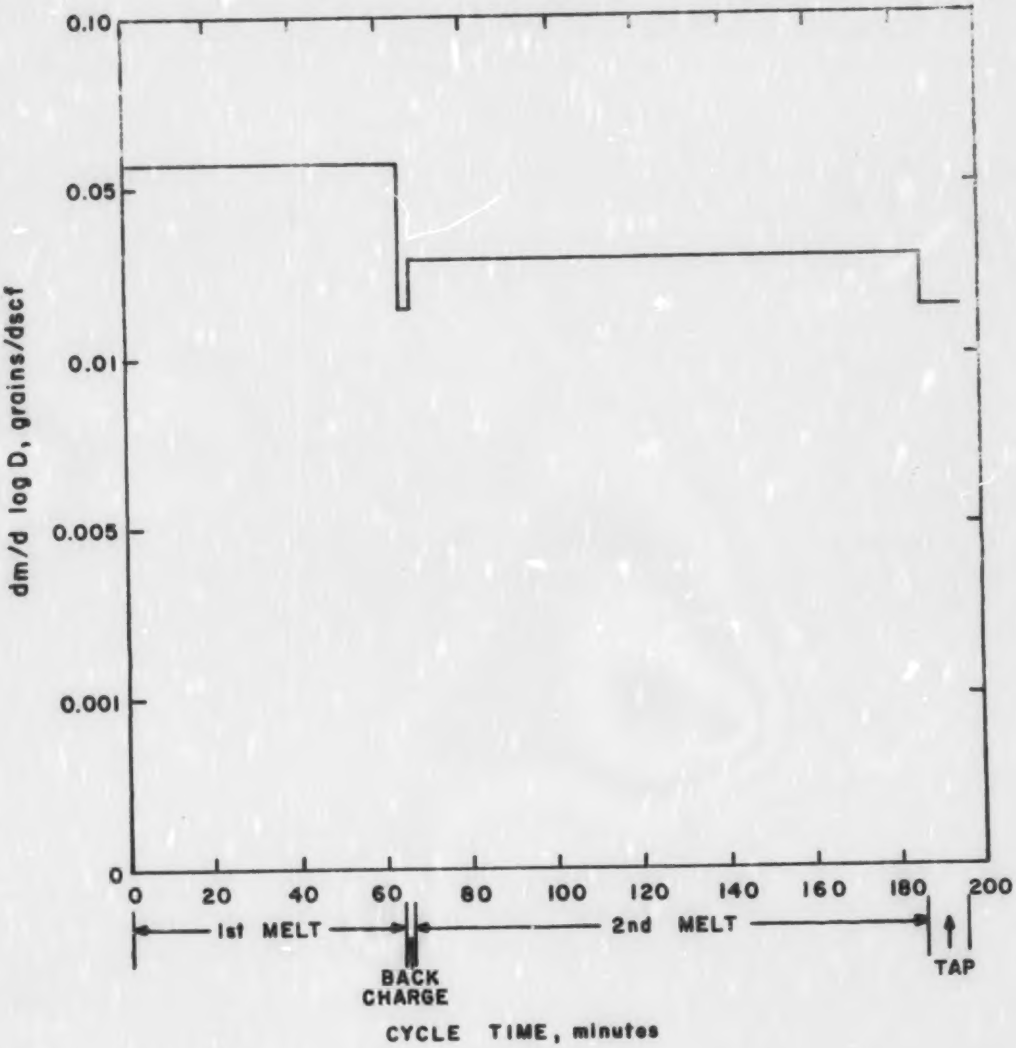


Figure 15a. Concentration versus process cycle for 1 μm particles

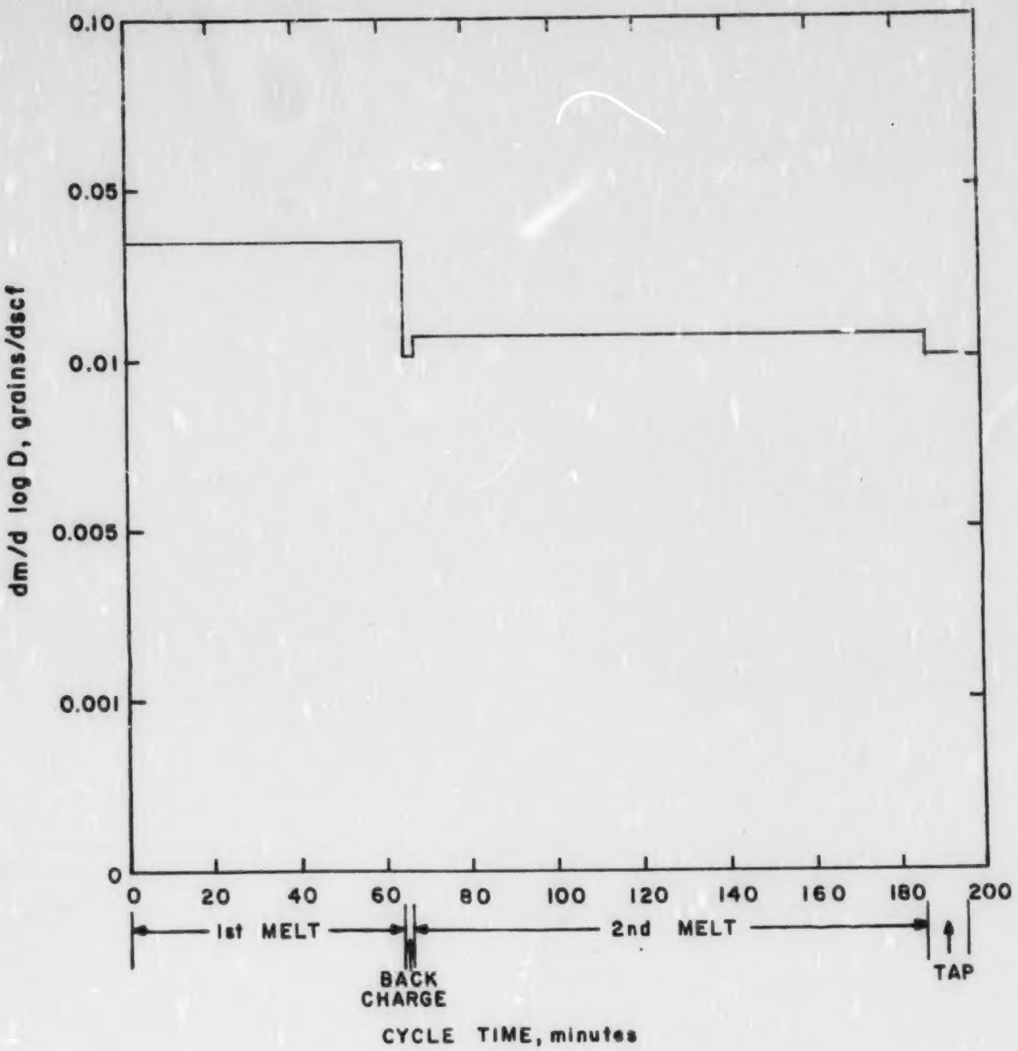


Figure 15b. Concentration versus process cycle for 2 μm particles

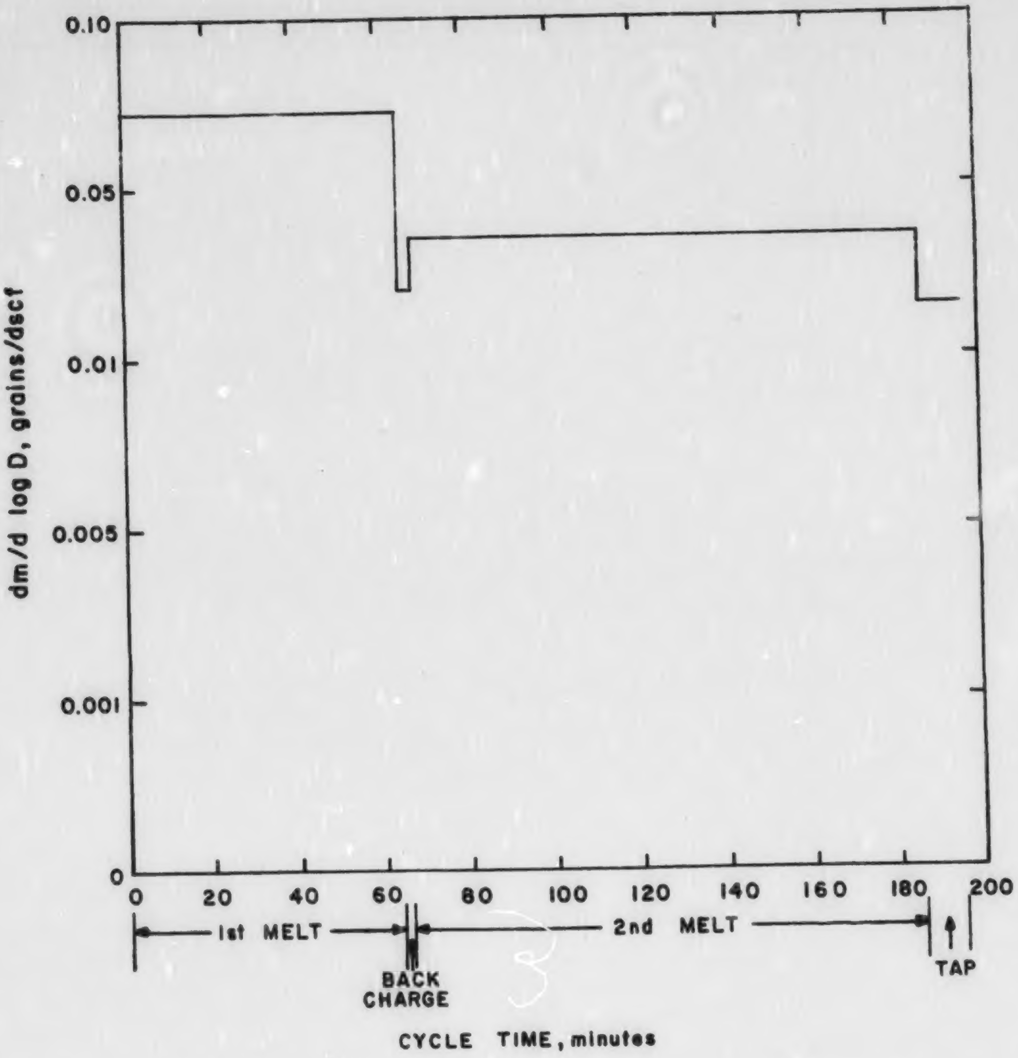


Figure 15c. Concentration versus process cycle for 4 μm particles

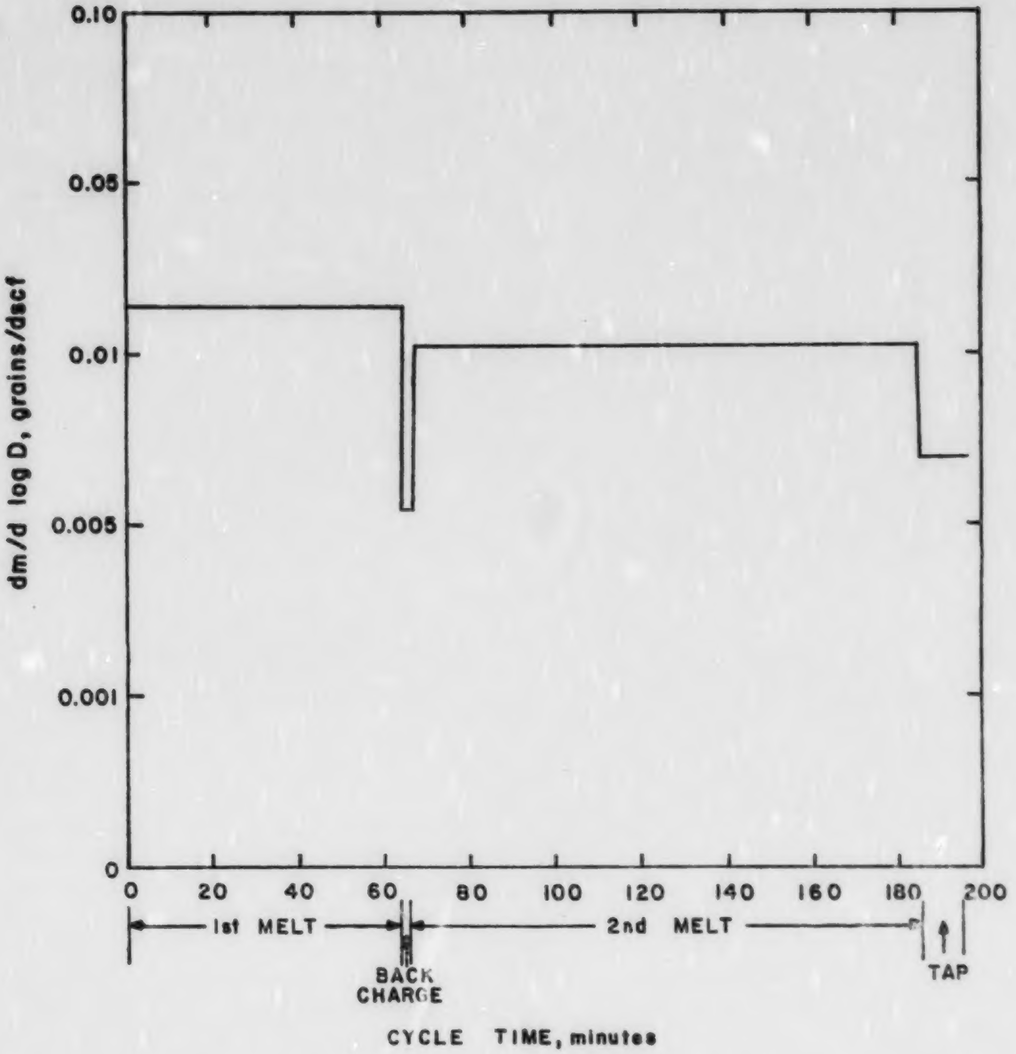


Figure 15d. Concentration versus process cycle for 6 μm particles

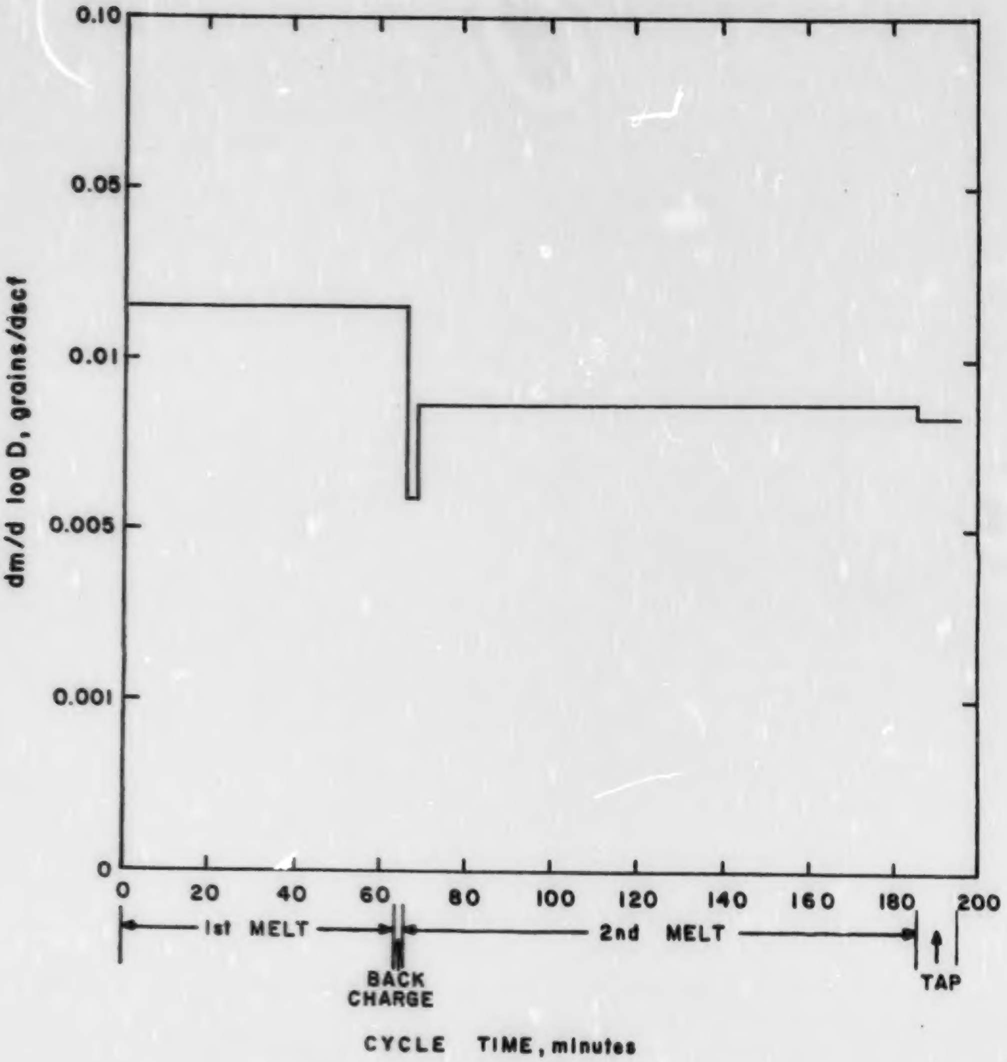


Figure 15e. Concentration versus process cycle for 8 μm particles

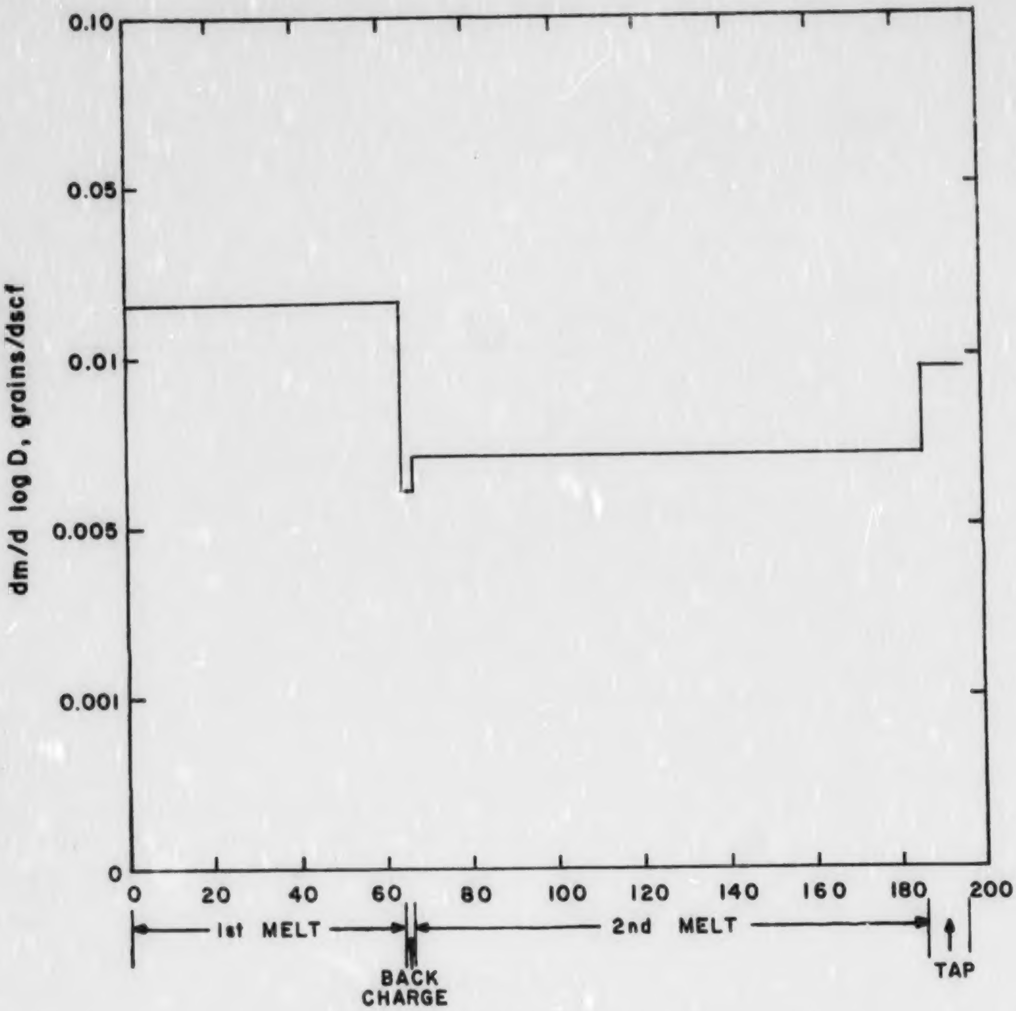


Figure 15f. Concentration versus process cycle for 10 μm particles

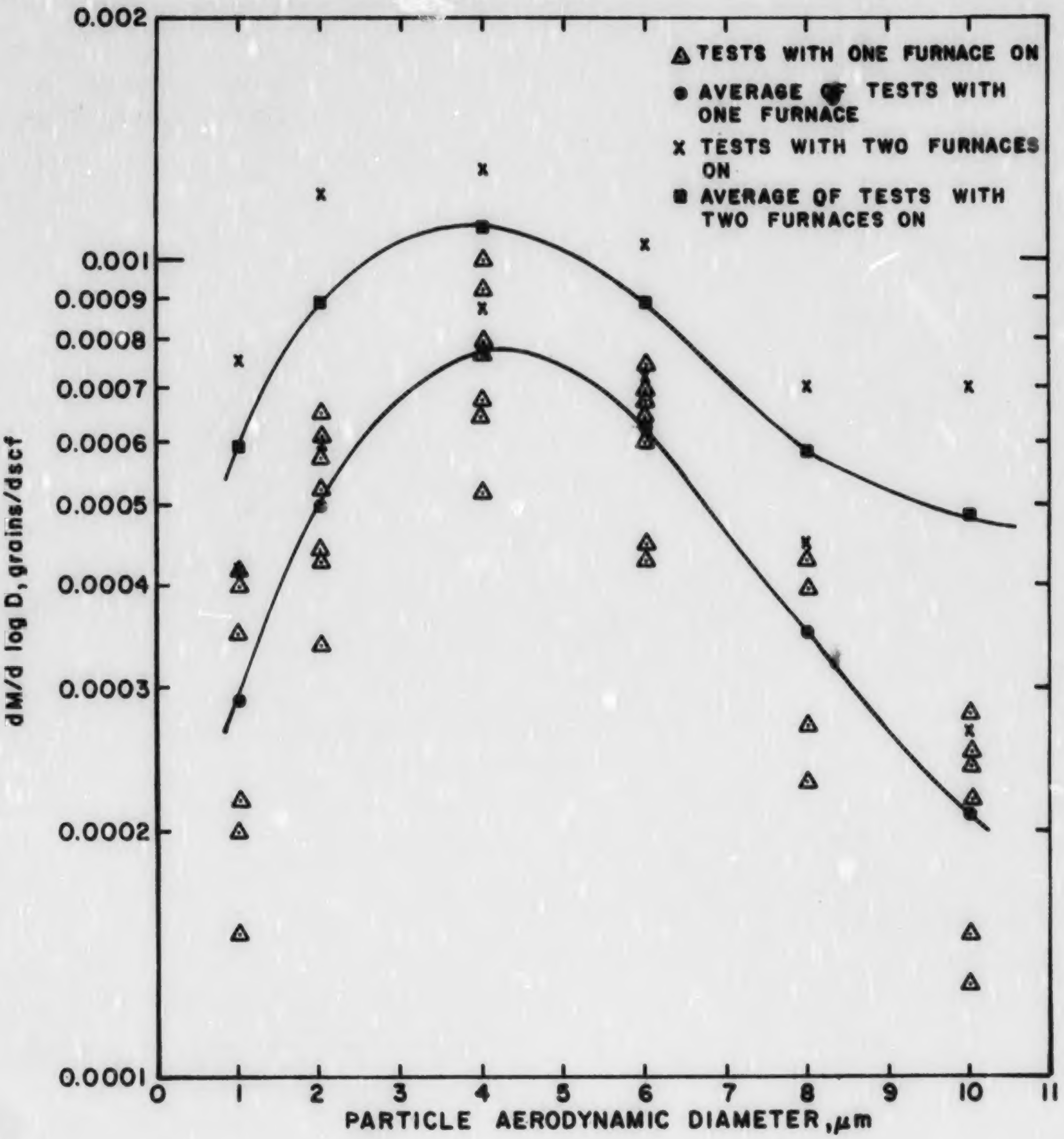


Figure 16. Average outlet differential size distribution curves for tests with one and two furnaces operating

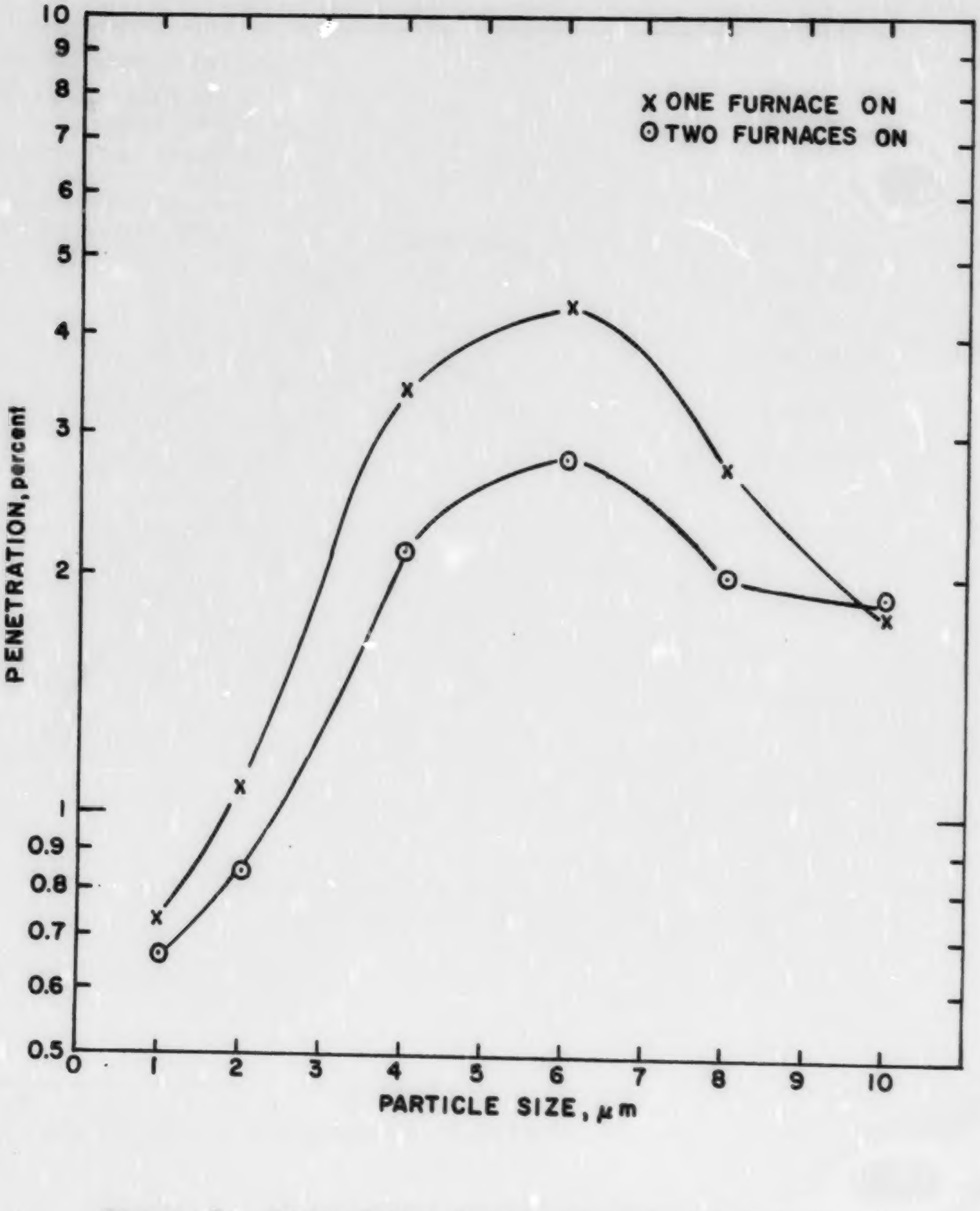


Figure 17. Fabric filter fractional penetration curves

FLUORIDE MEASUREMENTS

The inlet and outlet total mass samples collected during the first three tests were analyzed for fluorides. The results of the fluoride analyses are presented in Table 8. The total fluoride levels to which the bags were subjected are indicated by the inlet concentrations. The calculated penetrations (19 to 37 percent) were much higher than the total mass penetrations and are probably attributable to that portion of the fluorides in the gaseous form which passes through the baghouse without significant collection. Despite the fluoride levels measured, which are believed to be representative of normal operation, the Dacron^{TM} bags are still in service after 3 years without breakage problems. However, the physical characterization tests summarized in Table 1 show that the breaking strength and elongation of a 2-year old bag compared to a new bag had been reduced 15 to 20 percent. It is impossible to ascertain whether the reduction in breaking strength and elongation was the result of fabric deterioration due to fluorides or wear due to bag shaking during cleaning.

Table 8. RESULTS OF FLUORIDE ANALYSES

Test No.	Number of furnaces in operation	Inlet fluoride concentration, gr/dscf	Outlet fluoride concentration, gr/dscf	Penetration, percent
1	2	0.001062	0.0002013	18.95
2	2	0.0005651	0.0002087	36.93
3	1	0.0005218	0.0001768	33.88

CONDENSATION NUCLEI COUNTER AND DUST COUNTER MEASUREMENTS

A condensation nuclei counter (CNC) and an optical dust counter (DC) were used to monitor the fine particulate concentration in the baghouse influent and effluent to determine the total and fractional penetration of the fine particulate. The fine particle measurements have been tabulated in Appendix F. The measurements on each test day have been averaged and are listed in Table 9. The average daily mean inlet and outlet CNC measurements, which include particles over the range of 0.0025 μm to 0.5 μm, indicate penetrations of 0.14 percent and 0.17 percent by number for one and two furnace operation, respectively. When the DC inlet (except Test 9, which was suspiciously high) and outlet test day means were averaged, the penetrations for the DC which counts particles ≥ 0.3 μm were 4.9 percent and 1.0 percent by number for one and two furnace operations, respectively. Sizing with the CNC and diffusion denuder (DD) was inconclusive due to the variability of the fine particle concentration of the influent and effluent. Most of the inlet sizing with the DC was done during Test 9 which was inordinately high and therefore not presented. The inlet and outlet CNC measurements for tests 9 and 10 and the DC measurements for tests 5 and 10 are presented in Figures 18 and 19, respectively. The CNC inlet curve in Figure 18 shows a fluctuation of the inlet concentration which does not seem to correlate with events in the process or cleaning cycles. The CNC inlet measurements with the DD indicate that the majority of particles are ≥ 0.015 μm. The CNC outlet curve shows a strong dependence of concentration on compartment cleaning with every compartment cleaning corresponding to a peak outlet concentration. The CNC outlet sizing measurements indicate particles in the range of ≥ 0.0025 and ≤ 0.015 μm, few particles in the range of ≥ 0.015 and ≤ 0.078 μm with the remaining particles > 0.078 μm. The DC inlet measurements in Figure 19 show that the particles ≥ 0.3 μm seem to follow the process with their maximum concentration occurring at "power on" and the beginning of the "second melt." The outlet measurements show little fluctuation for particles ≥ 0.3 μm; however, the ≥ 0.5 and ≥ 1.0 μm outlet particles show some relationship between concentration and compartment cleaning, but the relationship is not always evident.

Table 9. RESULTS OF FINE PARTICLE MEASUREMENTS ON THE BAGHOUSE INFLUENT AND EFFLUENT AT MARATHON LETOURNEAU

		Influent				Effluent			
		Particle concentration, part./m^3 x 10^{-6}				Particle concentration, part./m^3 x 10^{-6}			
Run No.	No. furnaces in operation	CNC[a] mean	CNC std. dev.	DC[b] mean	DC std. dev.	CNC mean	CNC std. dev.	DC mean	DC std. dev.
1	2	1.9 x 10^7	1.8 x 10^7	1,900	550				
2	2					31,000	42,000	20	19
3	1	No data							
4	1					20,000	17,000	20	18
5	1	5.3 x 10^6	3.8 x 10^6	850	1,100				
6	1					25,000	27,000	56	380
7	1	1.1 x 10^7	5.5 x 10^6	750	910				
8	1					32,000	35,000	11	13
9	1	7.0 x 10^6	3.0 x 10^6	22,000[c]	9,100				
10	1					29,000	29,000	70	5

[a] Condensation nuclei counter, counts particles $\geq$ 0.0025 μm.

[b] Dust counter, counts particles $\geq$ 0.3 μm.

[c] Concentration seems inordinately high compared with the other inlet DC concentrations.

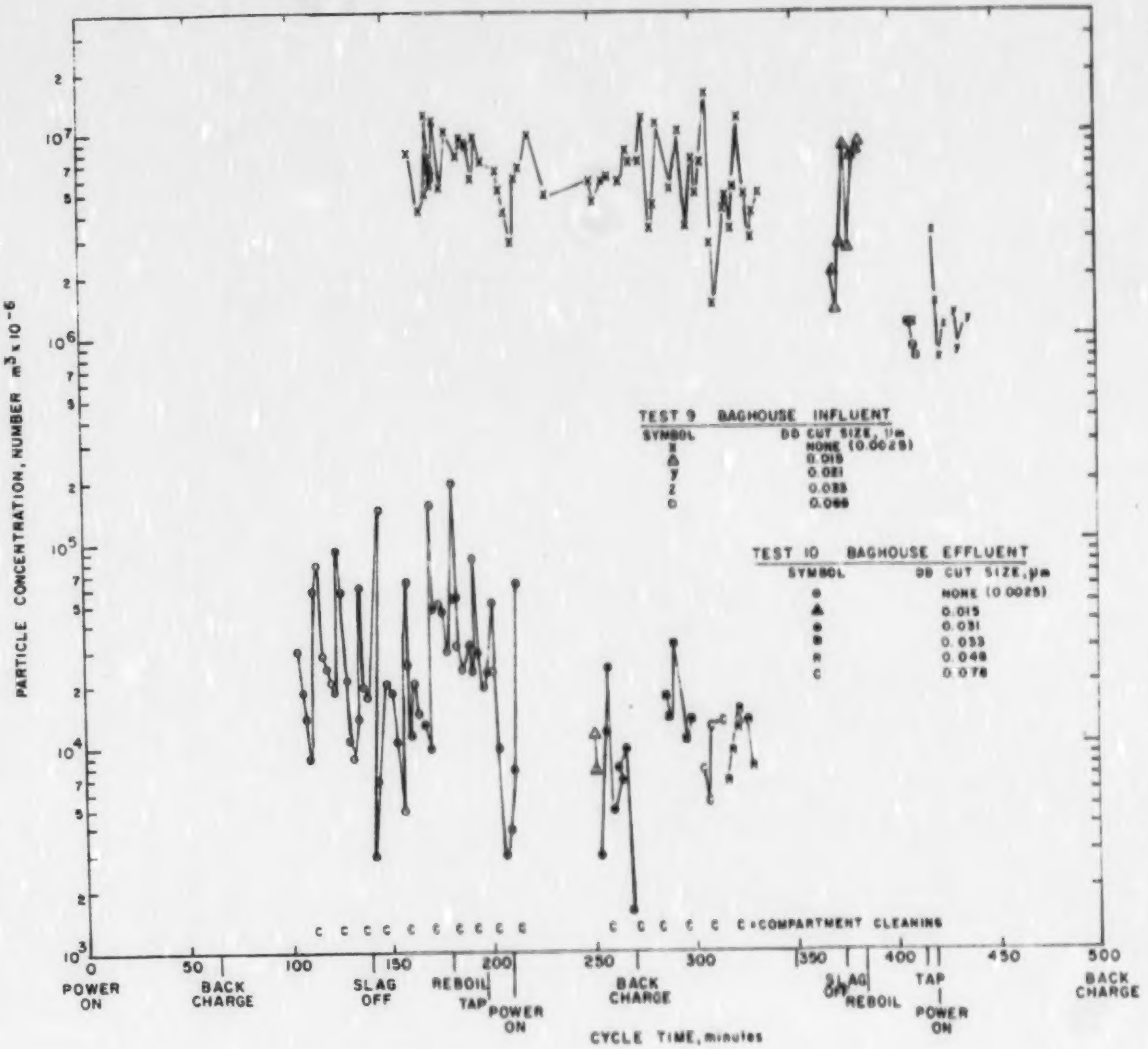


Figure 18. Condensation nuclei counter measured concentrations as a function of the process cycle and compartment cleaning

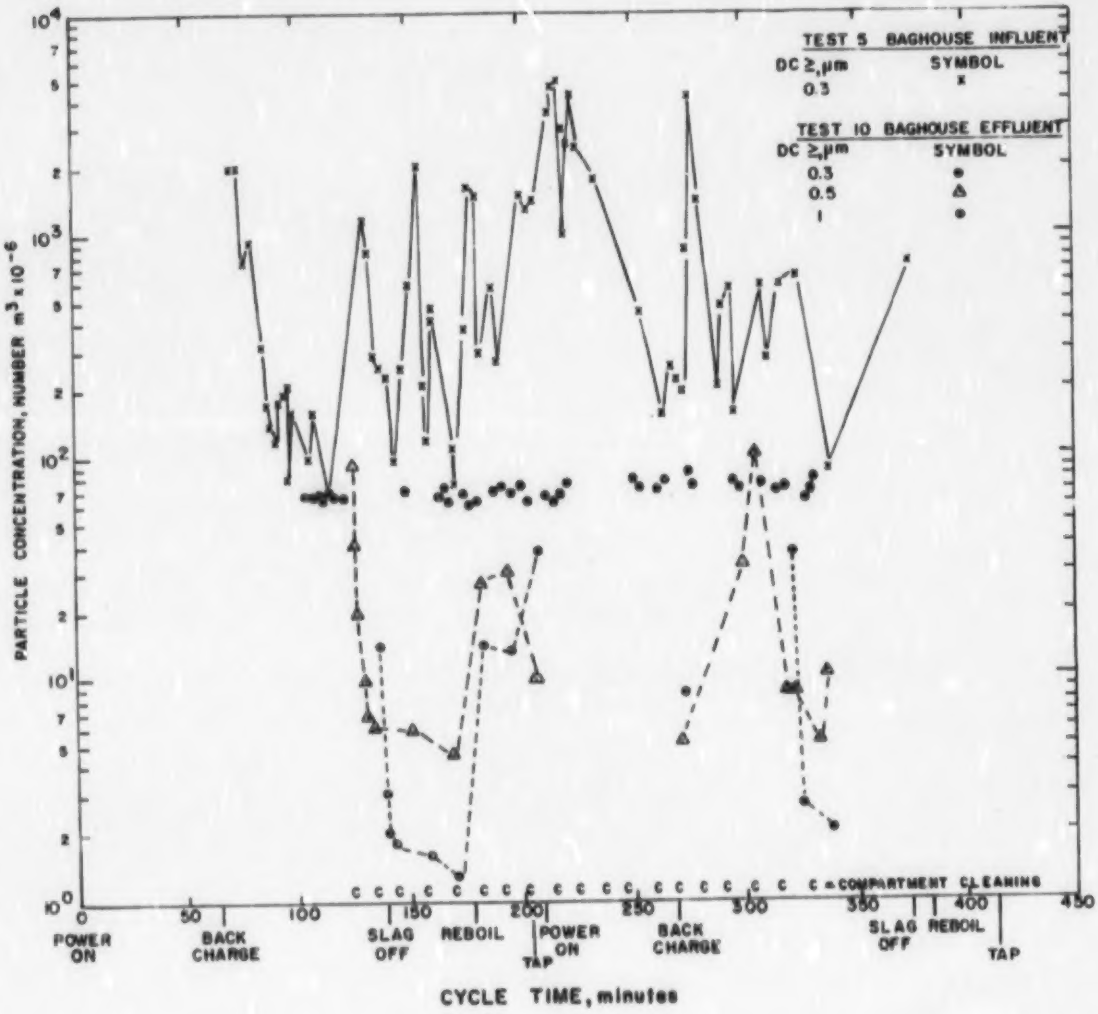


Figure 19. Dust counter measured concentrations as a function of the process cycle and compartment cleaning

SECTION VII

REFERENCES

1. Federal Register. Vol. 40, No. 185, September 23, 1975.

2. Federal Register. Vol. 39, No. 206, October 23, 1974.

3. Calvert, S., C. Lake, and R. Parker. Cascade Impactor Calibration Guidelines. U.S. Environmental Protection Agency. Publication Number EPA-600/2-76-118.

4. Personal communication with Joe McCain, Southern Research Institute.

5. Cass, R. W. and R. M. Bradway. Fractional Efficiency of a Utility Boiler Baghouse: Sunbury Steam-Electric Station. EPA-600/2-76-077a.

6. Instrument Instruction Manual for Condensation Nuclei Monitor Model Rich 100, Environmental/One Corporation, Schenectady, New York.

7. Personal communication with Mr. Ernie Demetrie, Environment/One Corporation, Schenectady, New York.

APPENDIX A

PARTICLE SIZE DISTRIBUTION CURVES

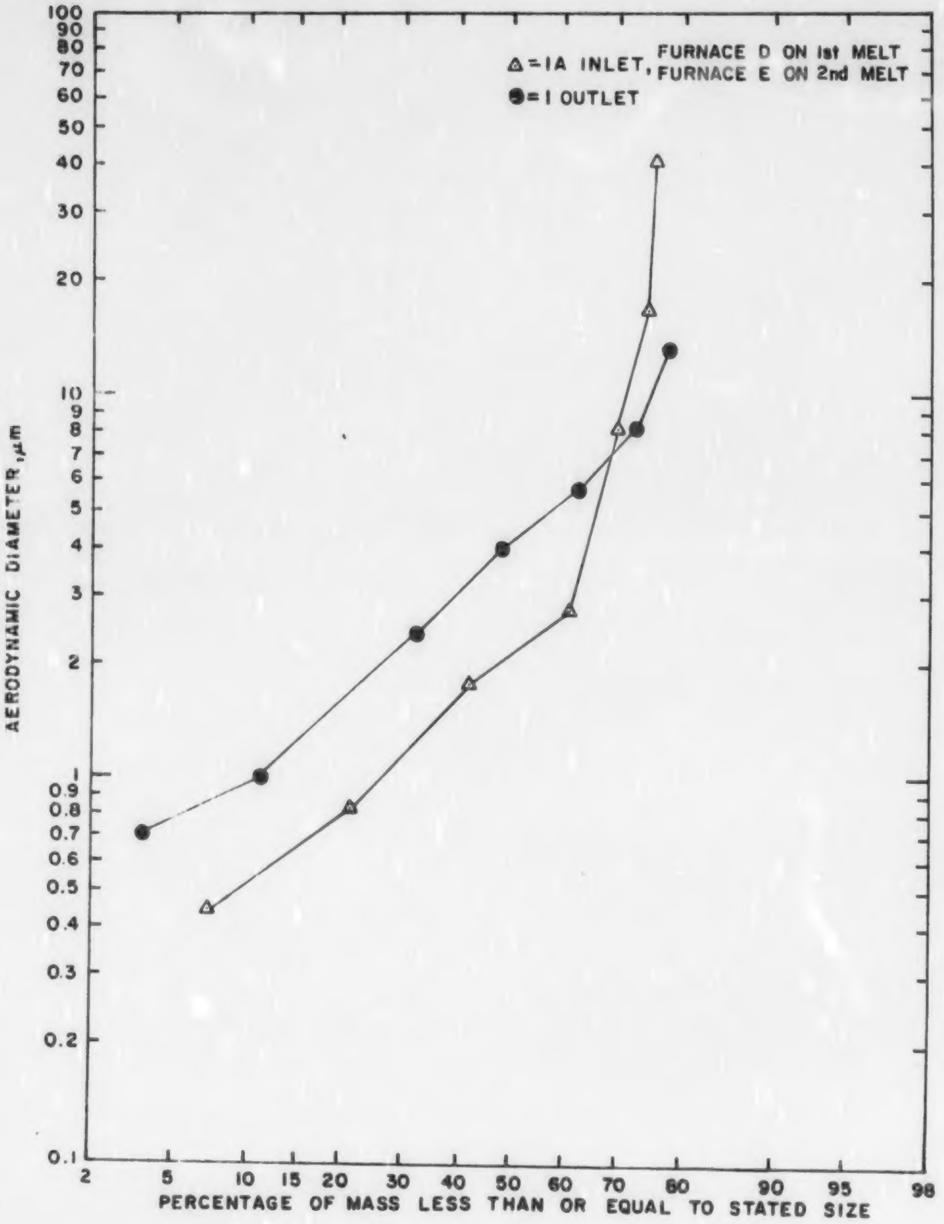


Figure A-1. Cumulative particle size distributions of fabric filter influent and effluent during test 1, two furnaces in operation

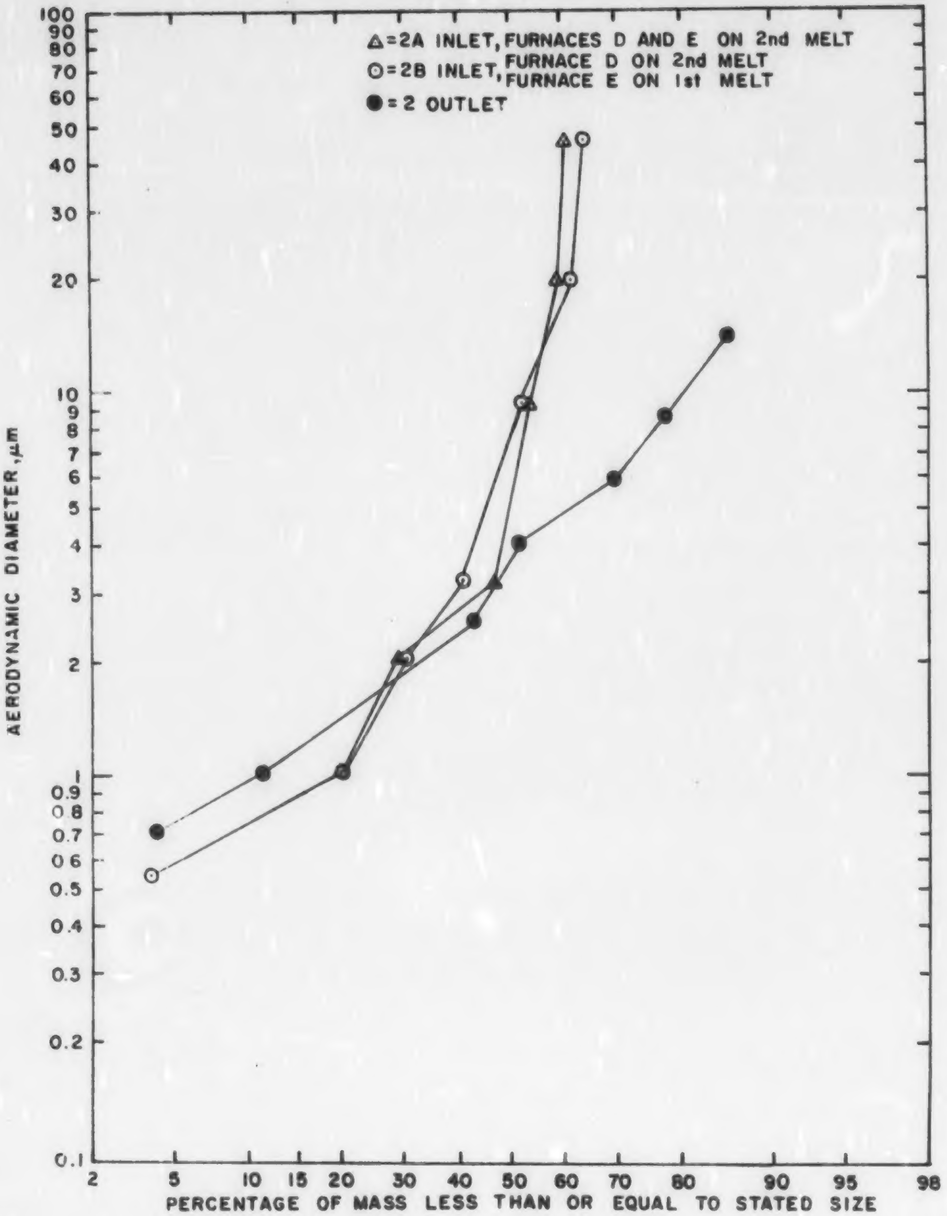


Figure A-2. Cumulative particle size distribution of fabric filter influent and effluent during test 2, two furnaces in operation

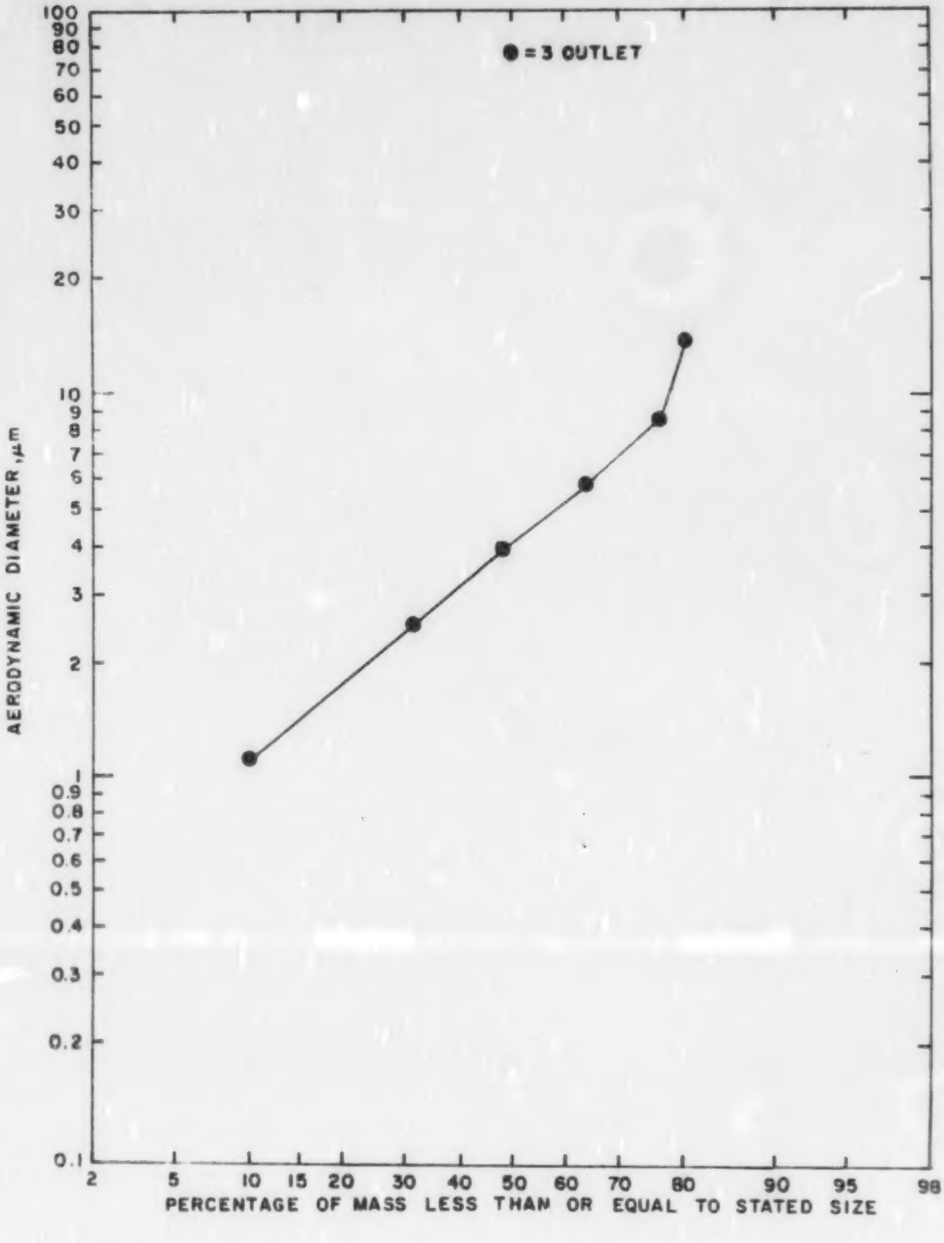


Figure A-3. Cumulative particle size distribution of fabric filter effluent during test 3, one furnace in operation

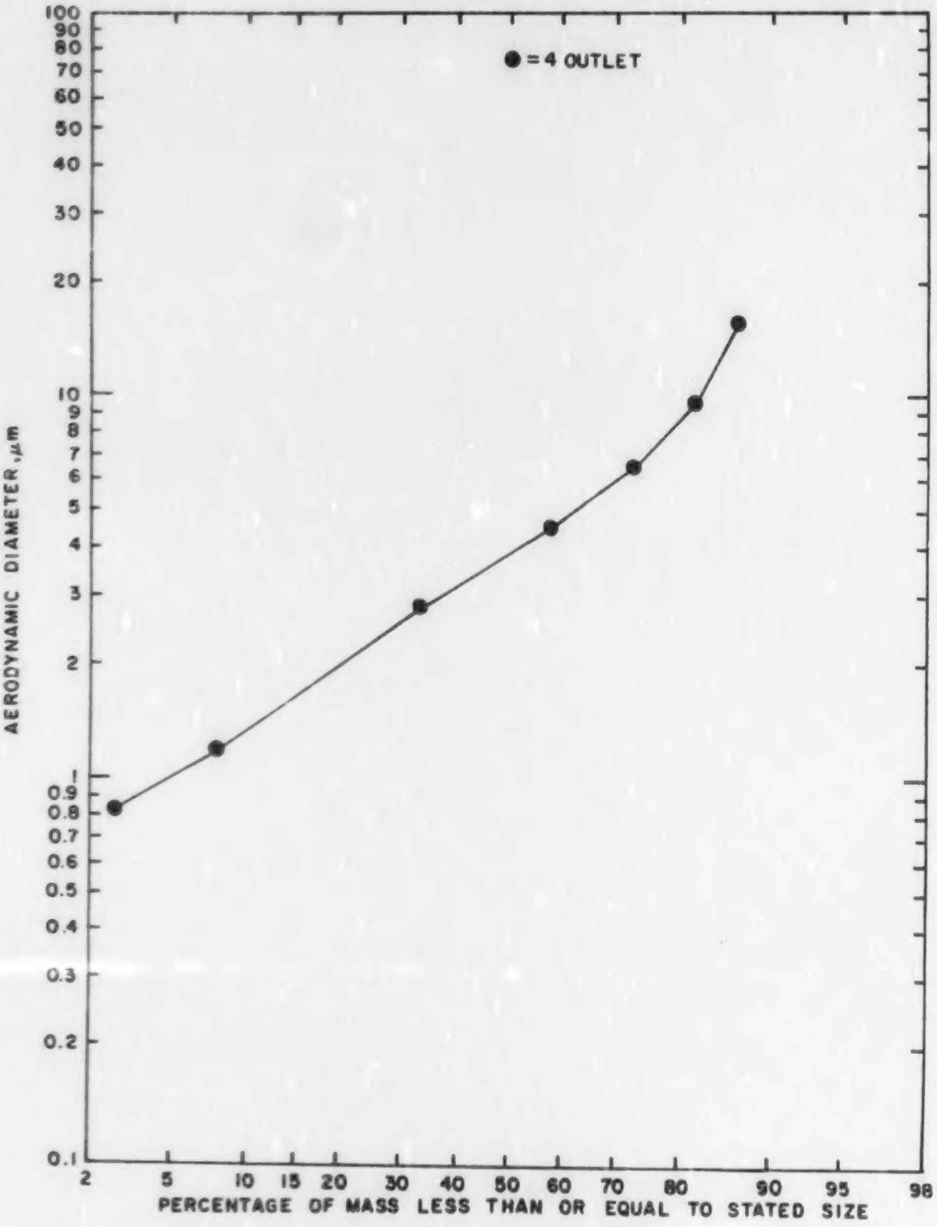


Figure A-4. Cumulative particle size distribution of fabric filter effluent during test 4, one furnace in operation

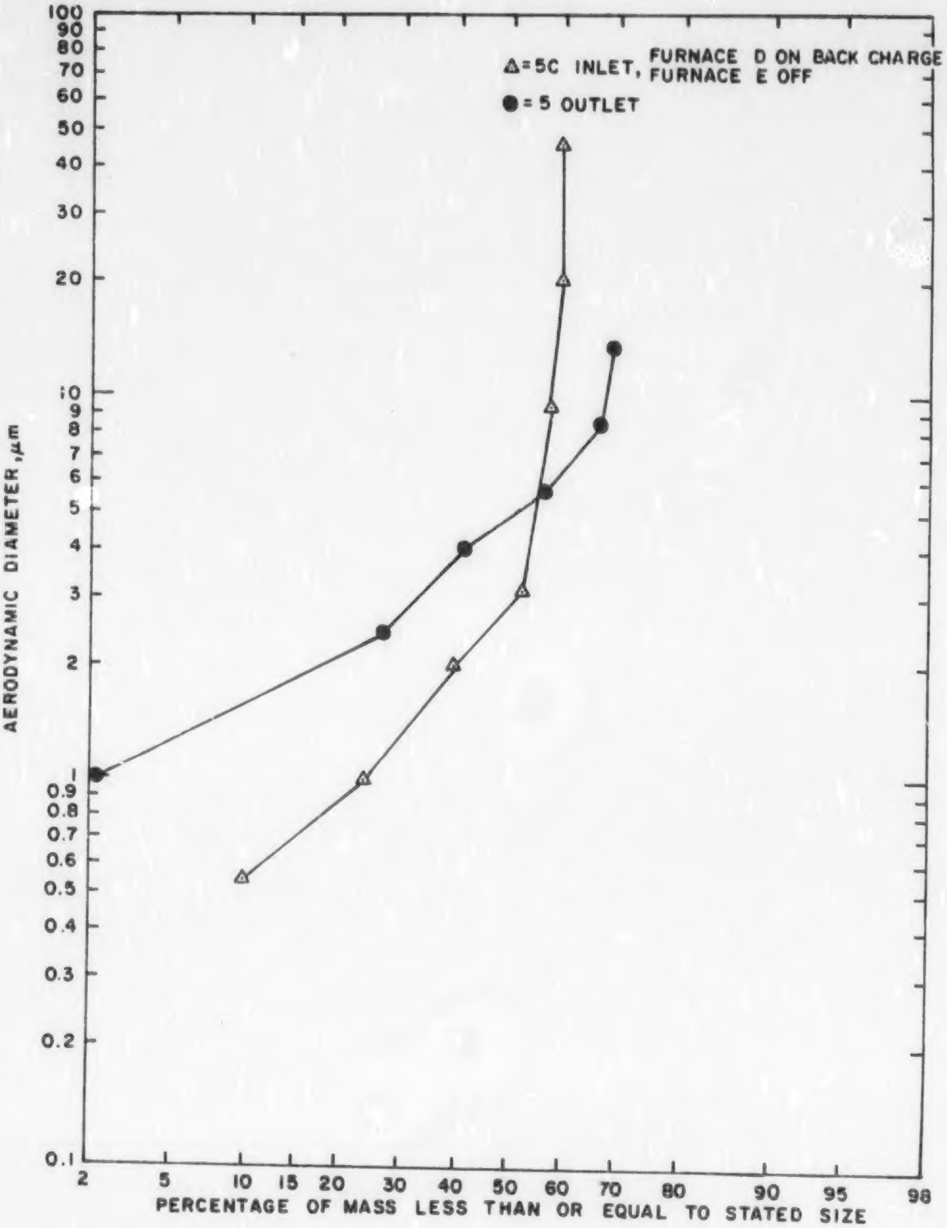


Figure A-5. Cumulative particle size distribution of fabric filter influent and effluent during test 5, one furnace in operation

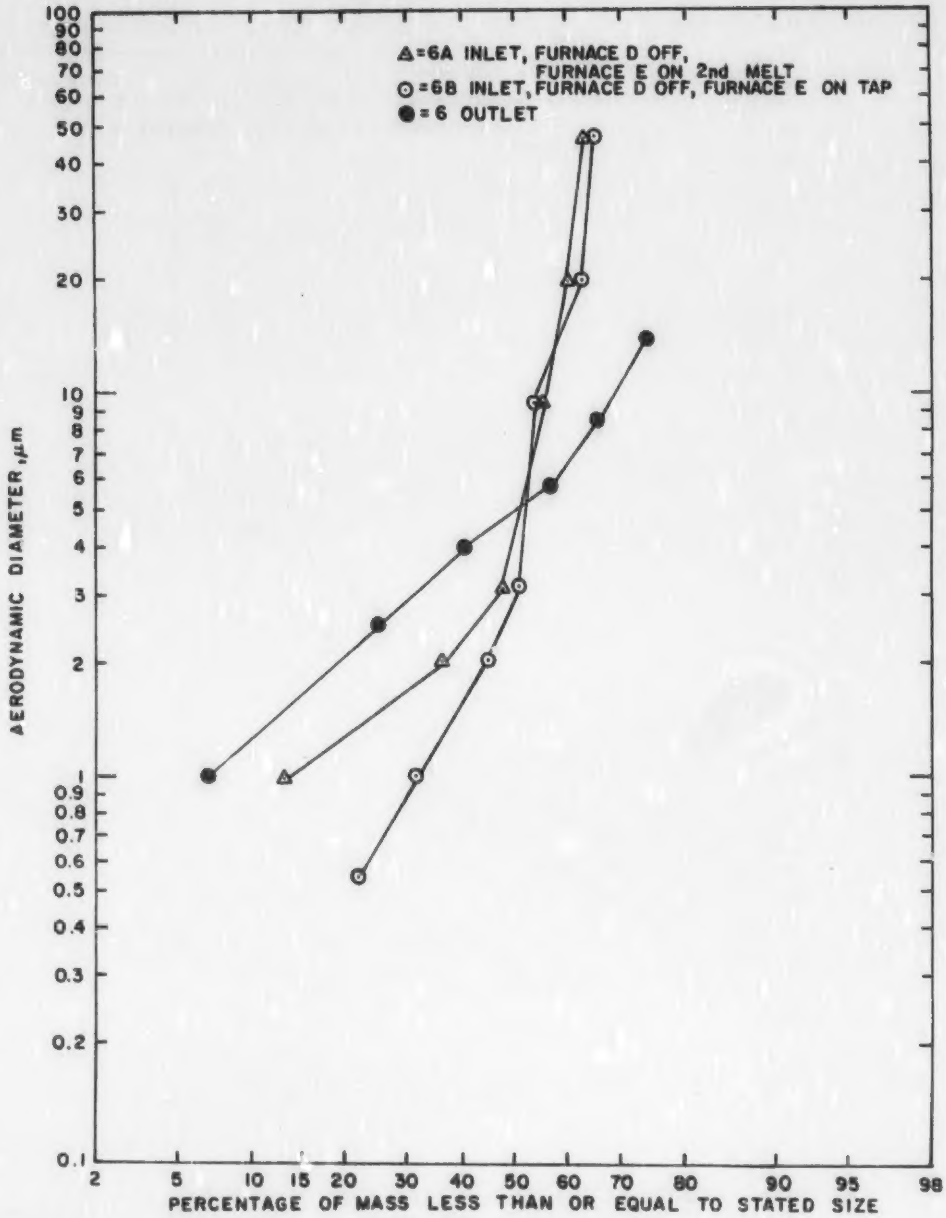


Figure A-6. Cumulative particle size distributions of fabric filter influent and effluent during test 6, one furnace in operation

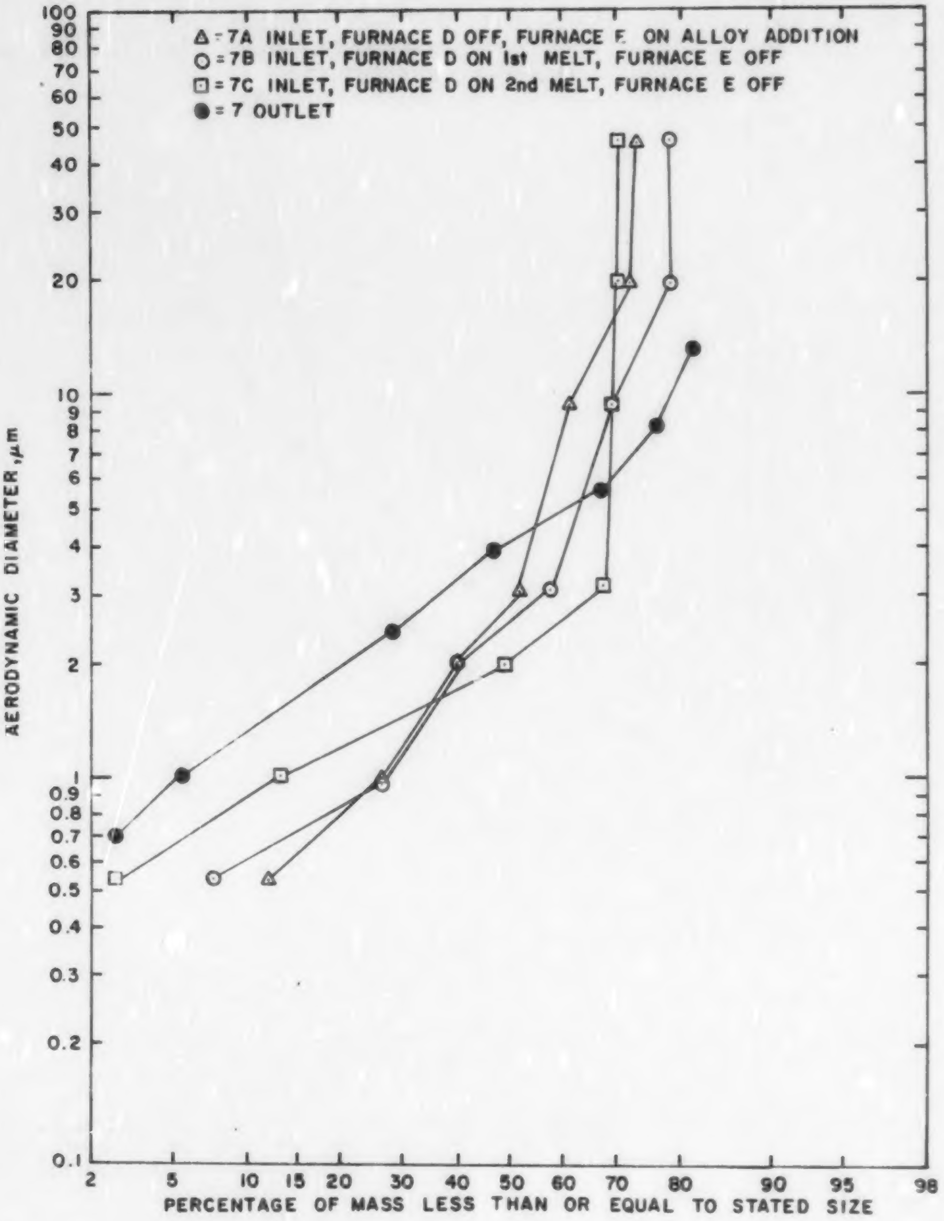


Figure A-7. Cumulative particle size distributions of fabric filter influent and effluent during test 7, one furnace in operation

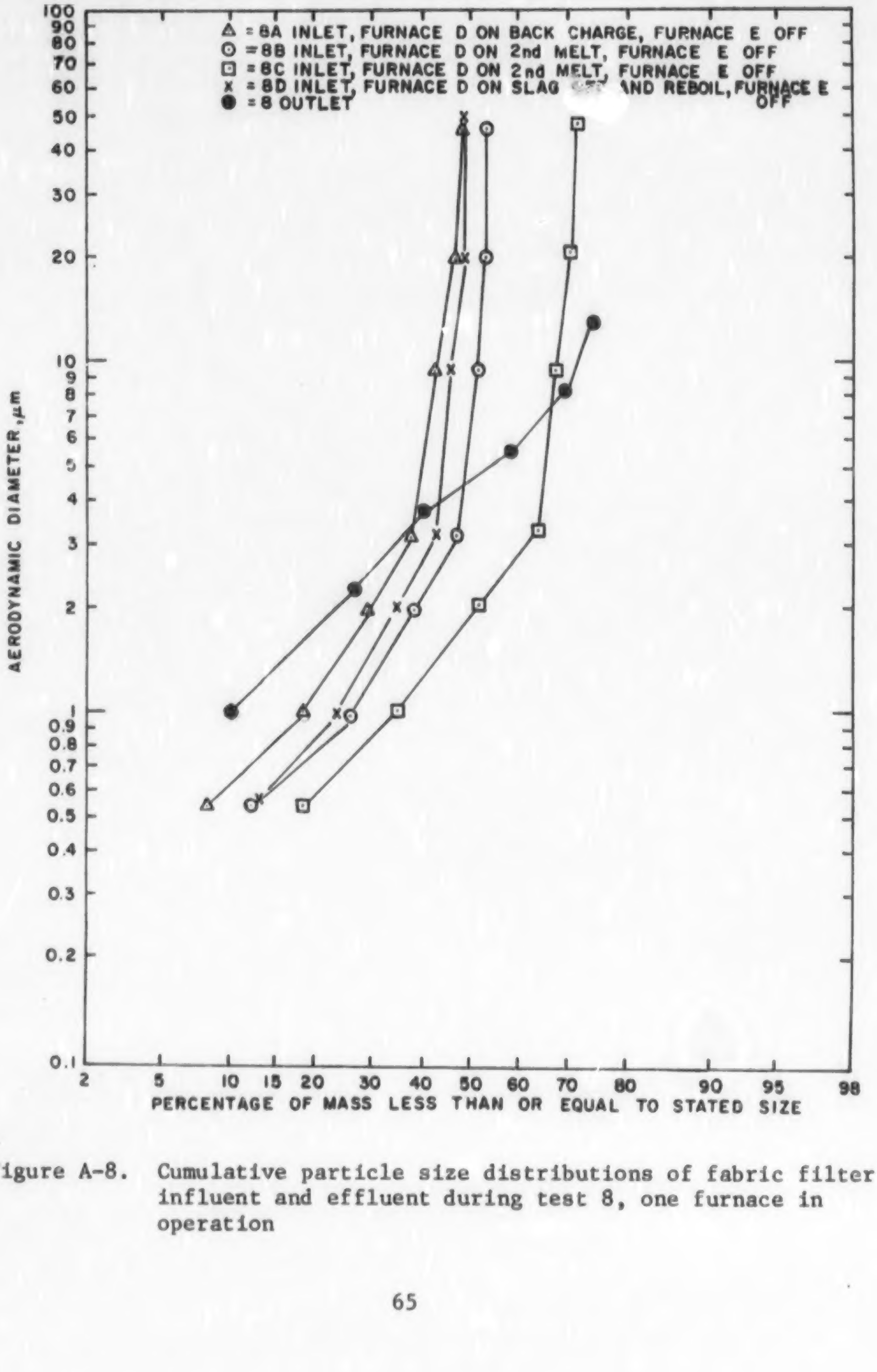


Figure A-8. Cumulative particle size distributions of fabric filter influent and effluent during test 8, one furnace in operation

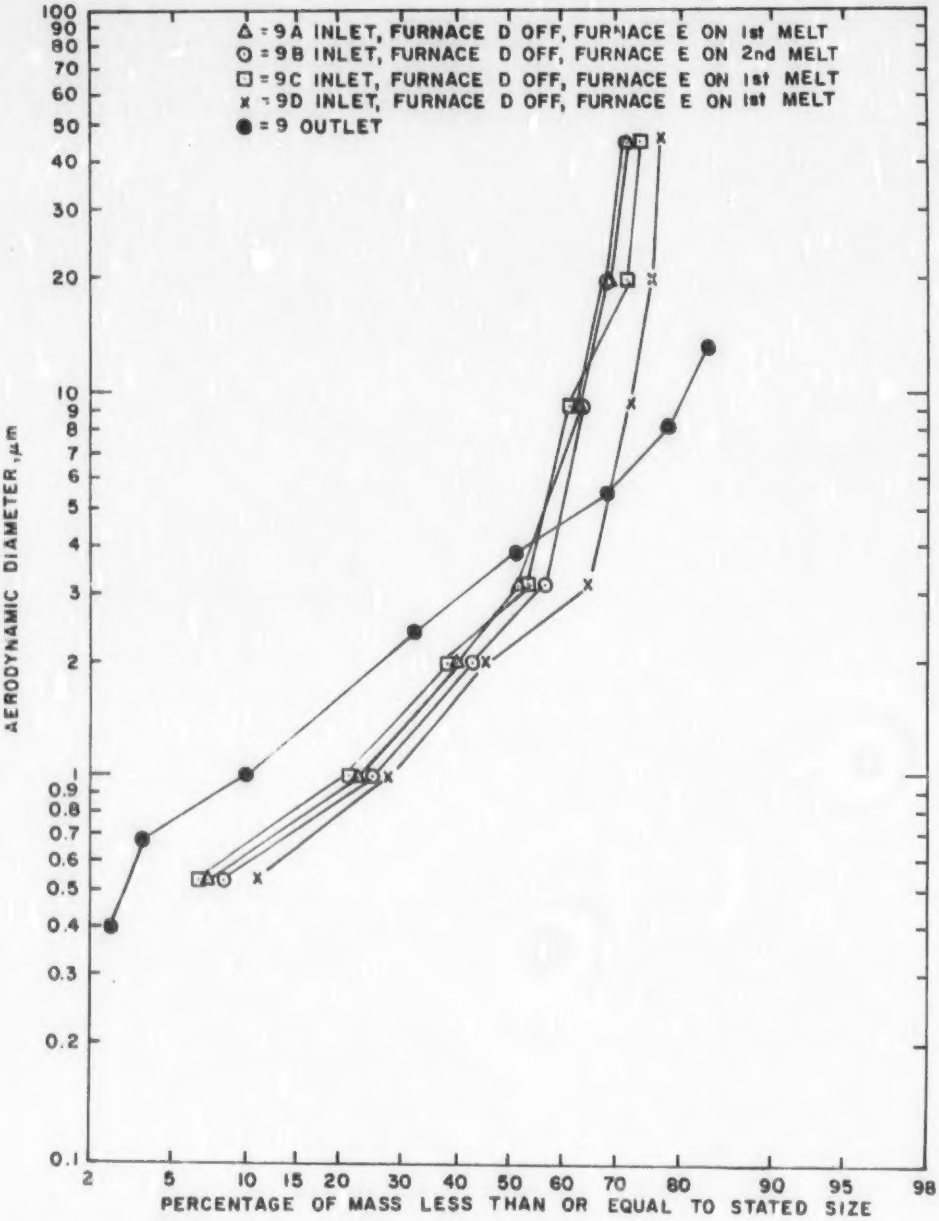


Figure A-9. Cumulative particle size distributions of fabric filter influent and effluent during test 9, one furnace in operation

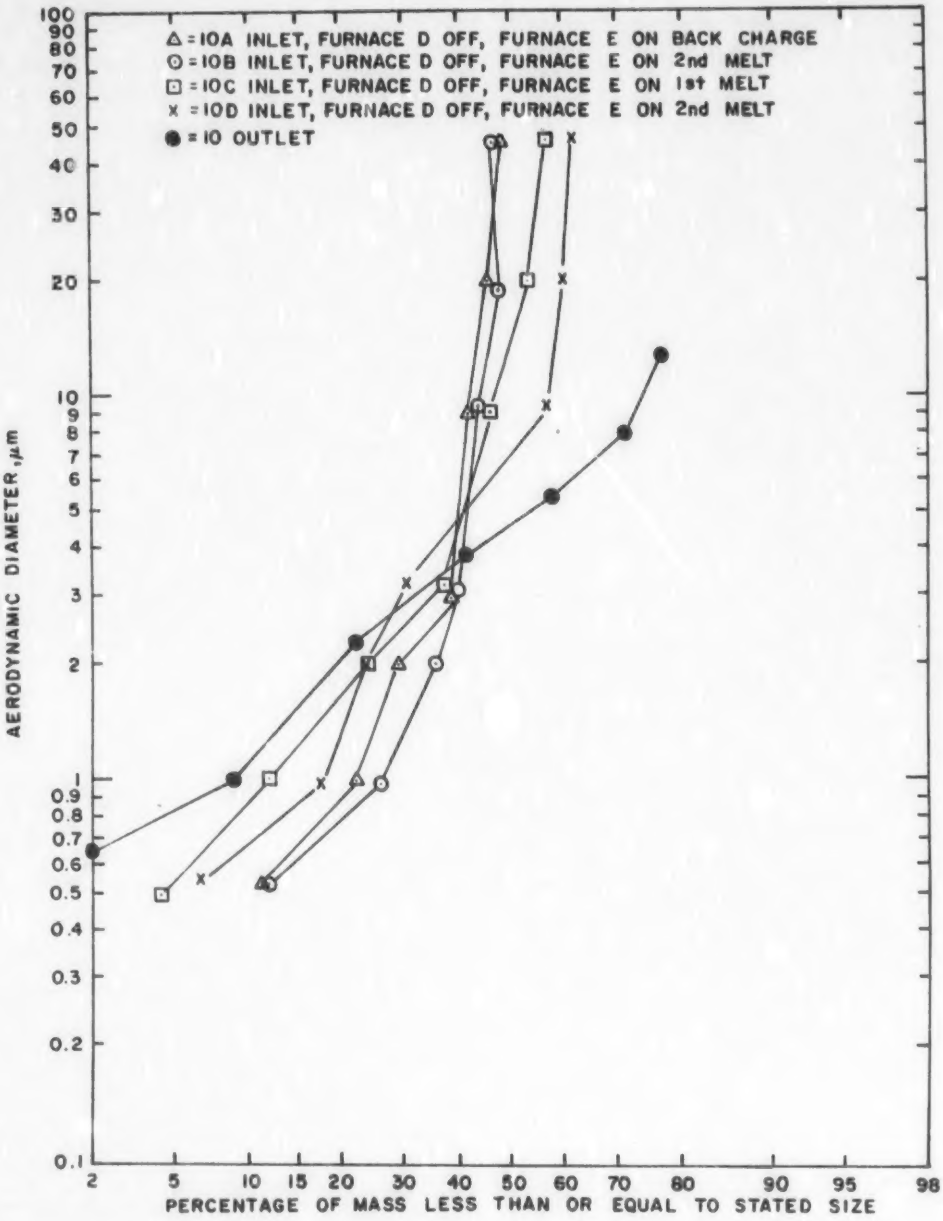


Figure A-10. Cumulative particle size distributions of fabric filter influent and effluent during test 10, one furnace in operation

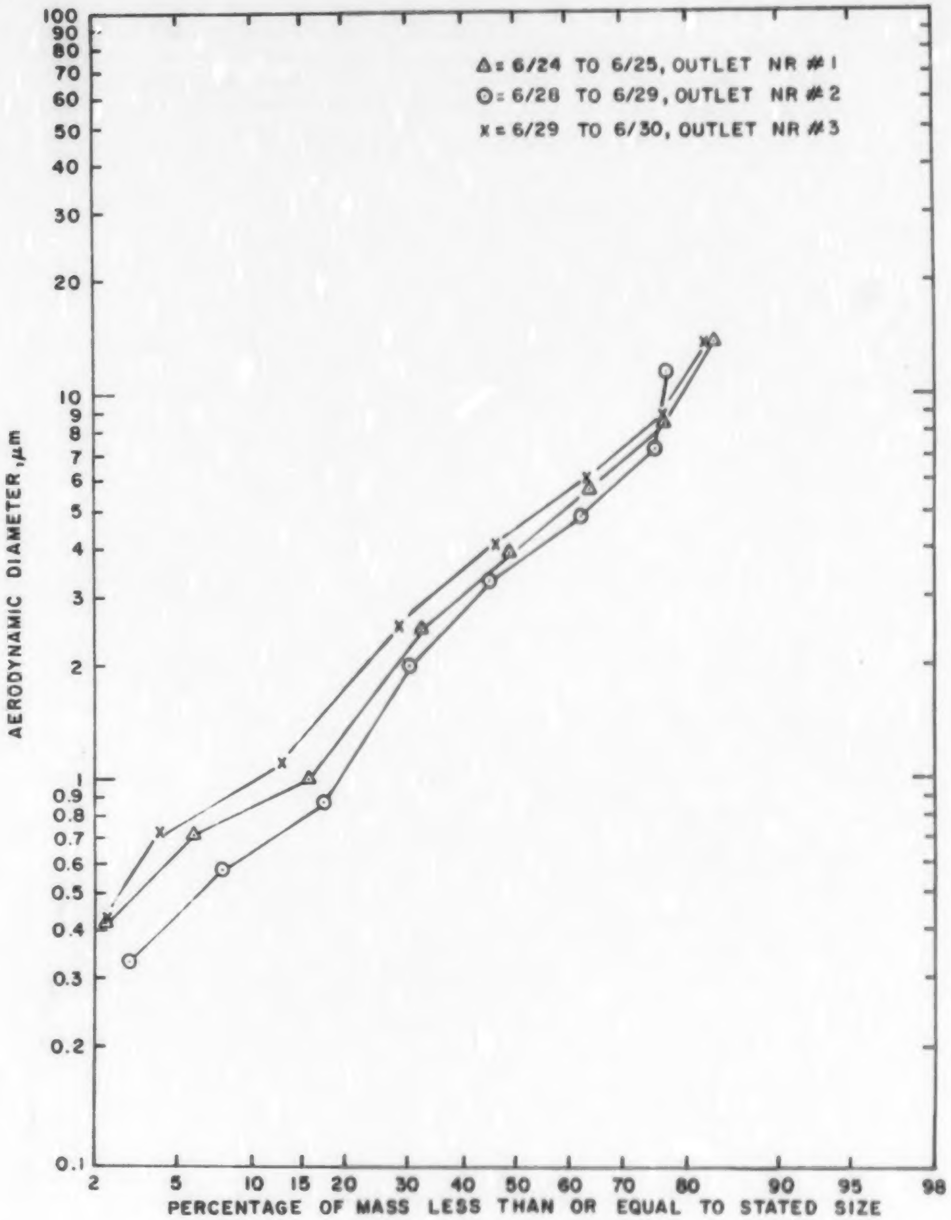


Figure A-11. Cumulative particle size distributions of fabric filter effluent during three special tests during which the impactors were run unattended overnight with one furnace in operation

APPENDIX B

DIFFERENTIAL SIZE DISTRIBUTION CURVES

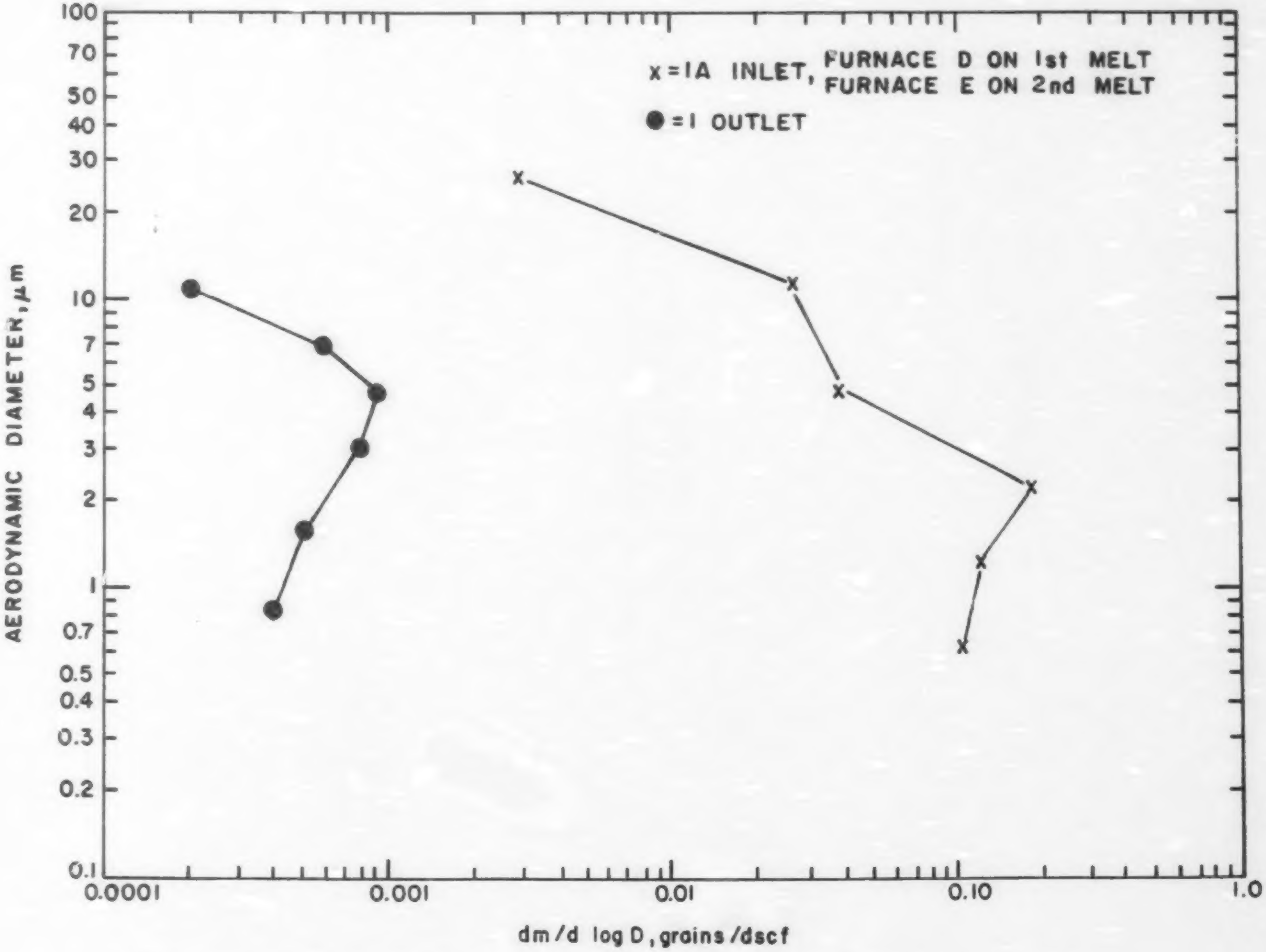


Figure B-1. Differential particle size distribution of baghouse influent and effluent during test 1, two furnaces in operation

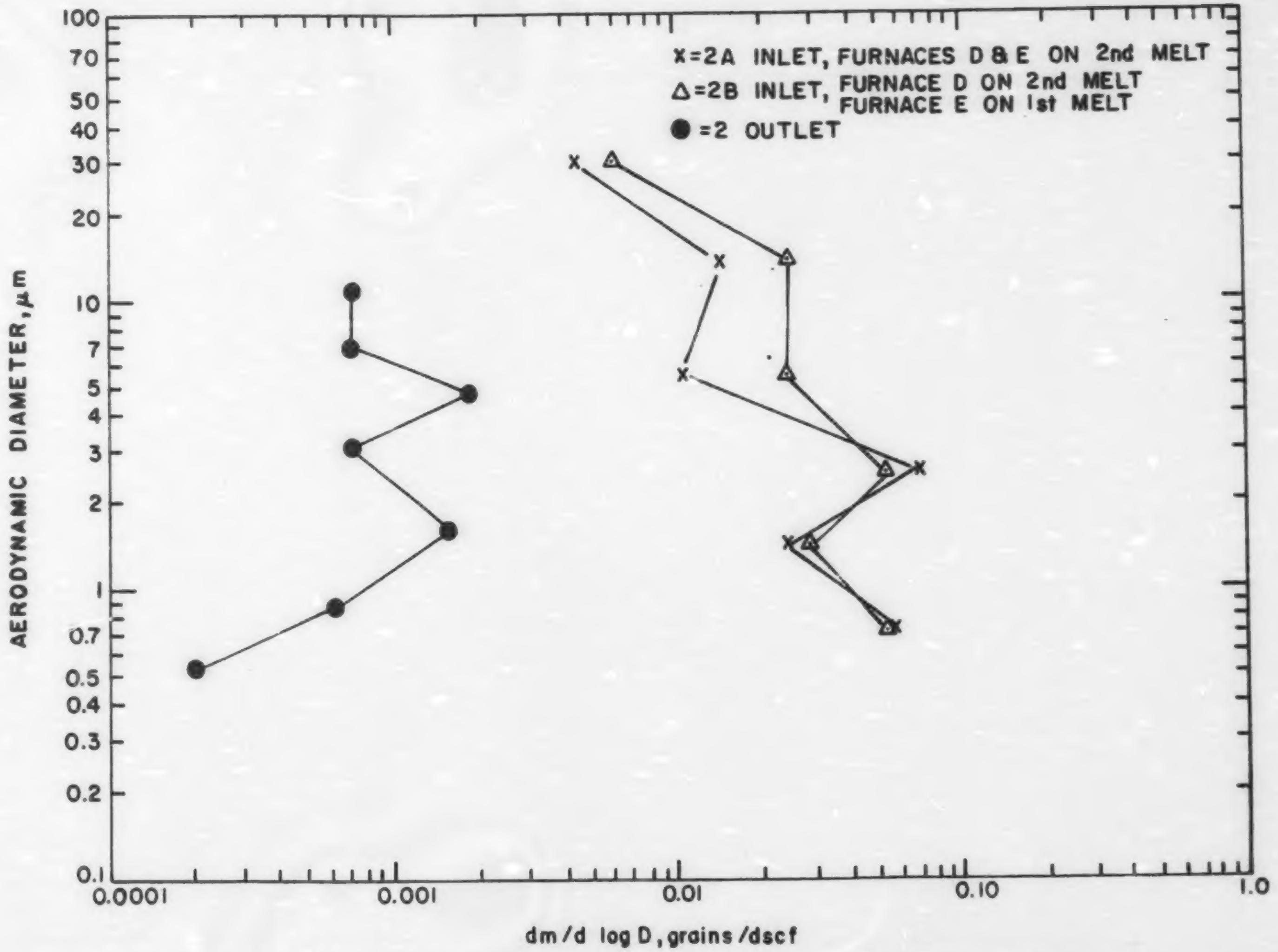


Figure B-2. Differential particle size distribution of baghouse influent and effluent during test 2, two furnaces in operation

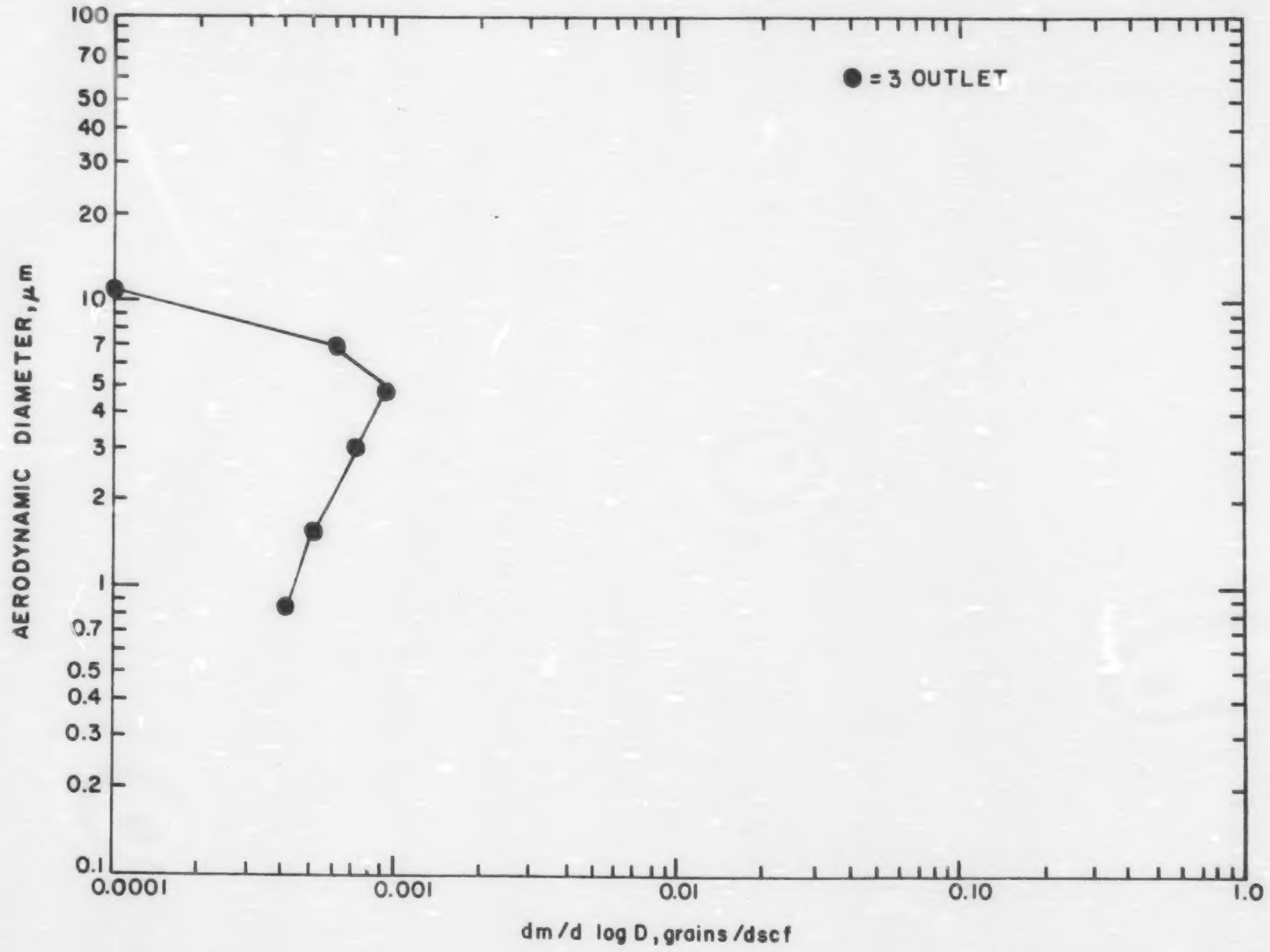


Figure B-3. Differential particle size distribution of baghouse effluent during test 3, one furnace in operation

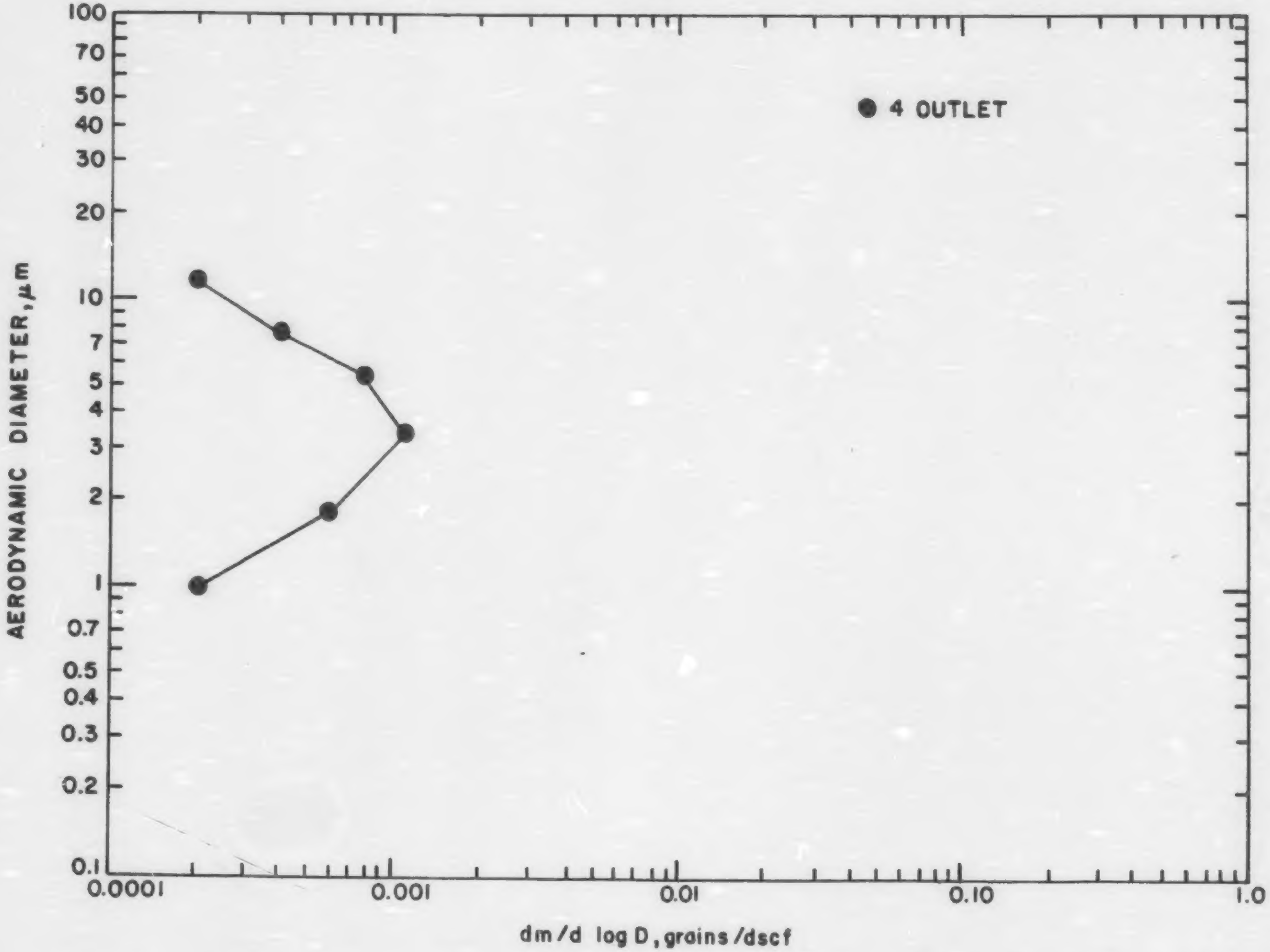


Figure B-4. Differential particle size distribution of baghouse effluent during test 4, one furnace in operation

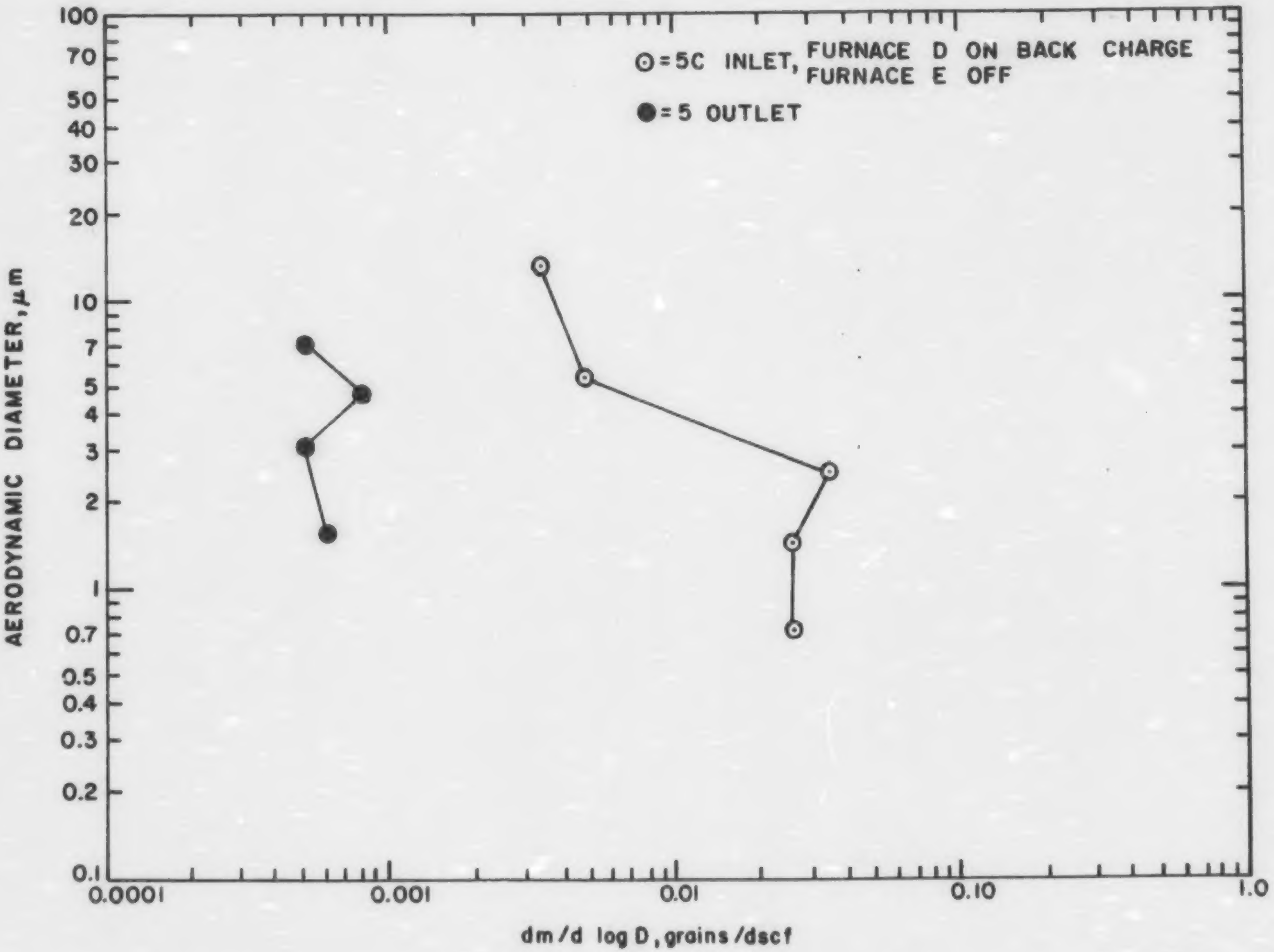


Figure B-5. Differential particle size distribution of baghouse influent and effluent during test 5, one furnace in operation

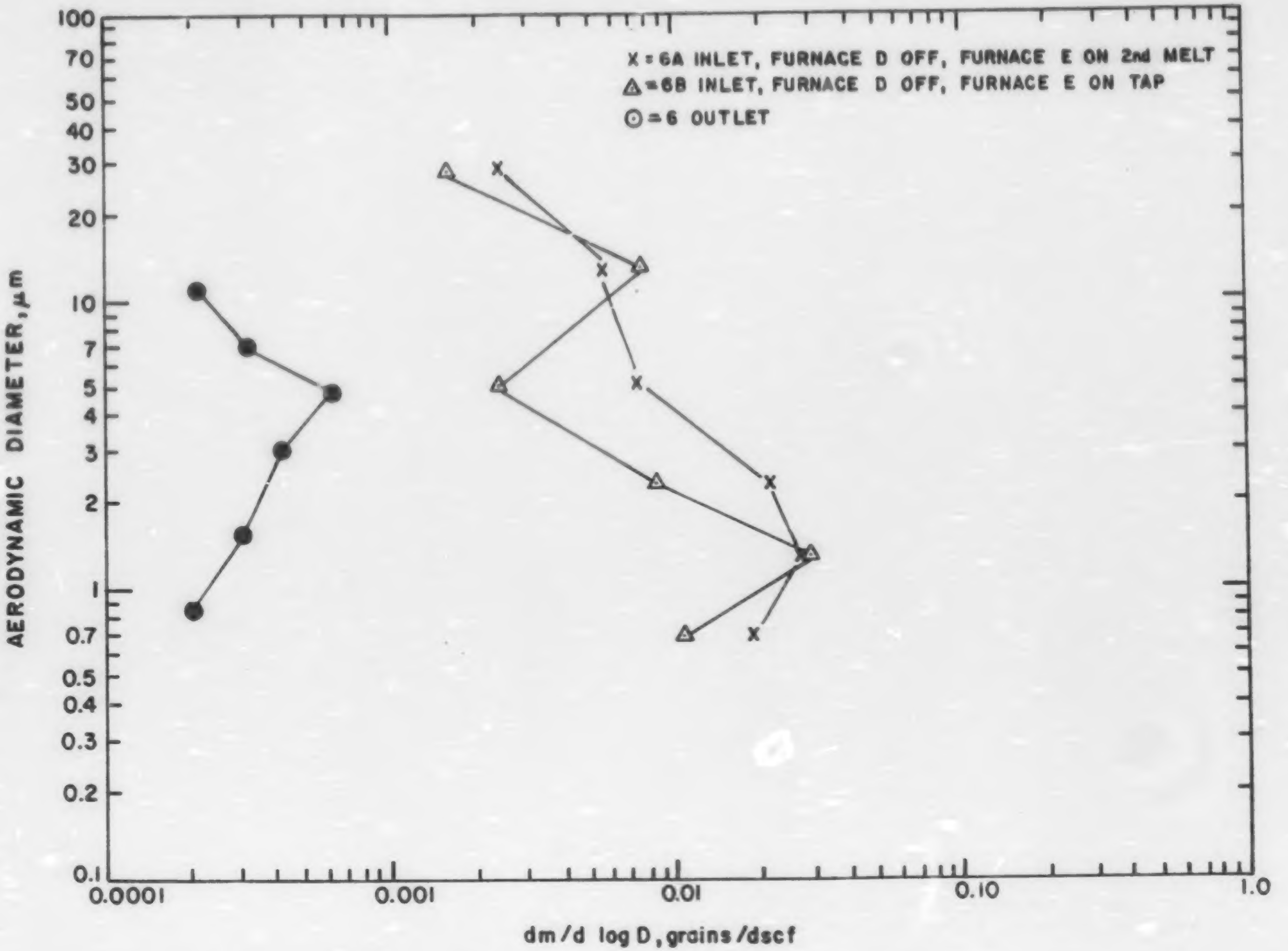


Figure B-6. Differential particle size distribution of baghouse influent and effluent during test 6, one furnace in operation

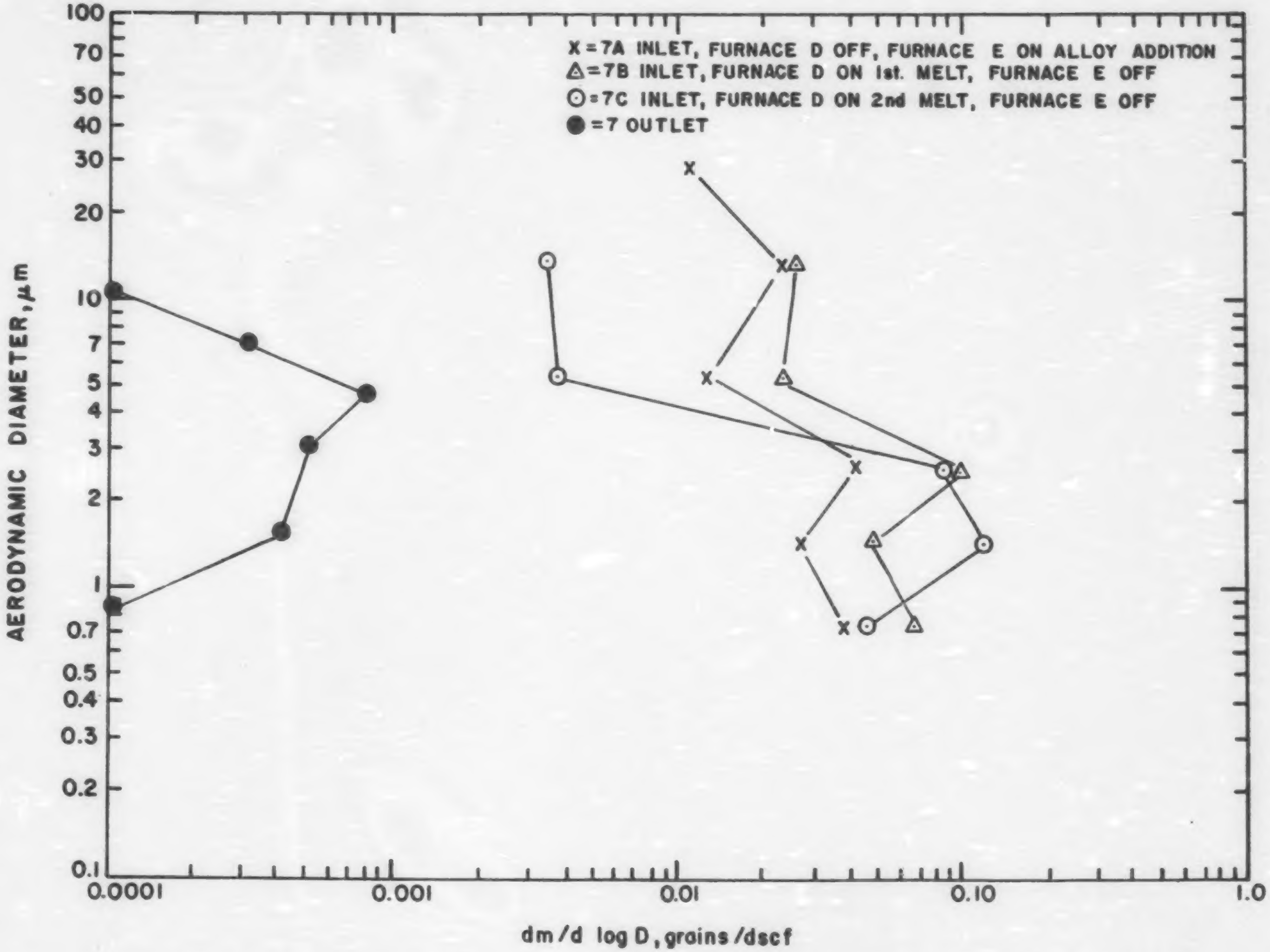


Figure B-7. Differential particle size distribution of baghouse influent and effluent during test 7, one furnace in operation

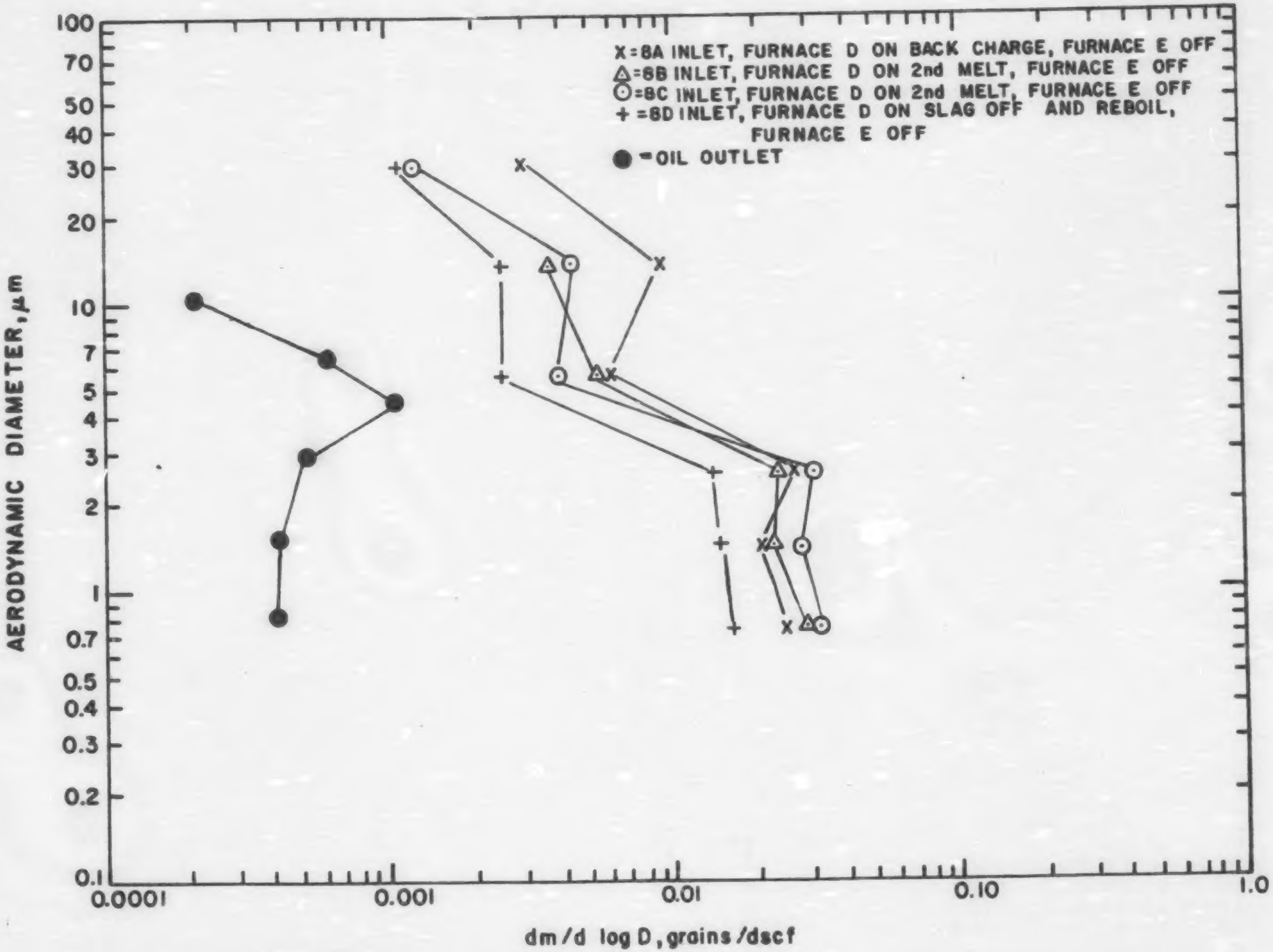


Figure B-8. Differential particle size distribution of baghouse influent and effluent during test 8, one furnace in operation

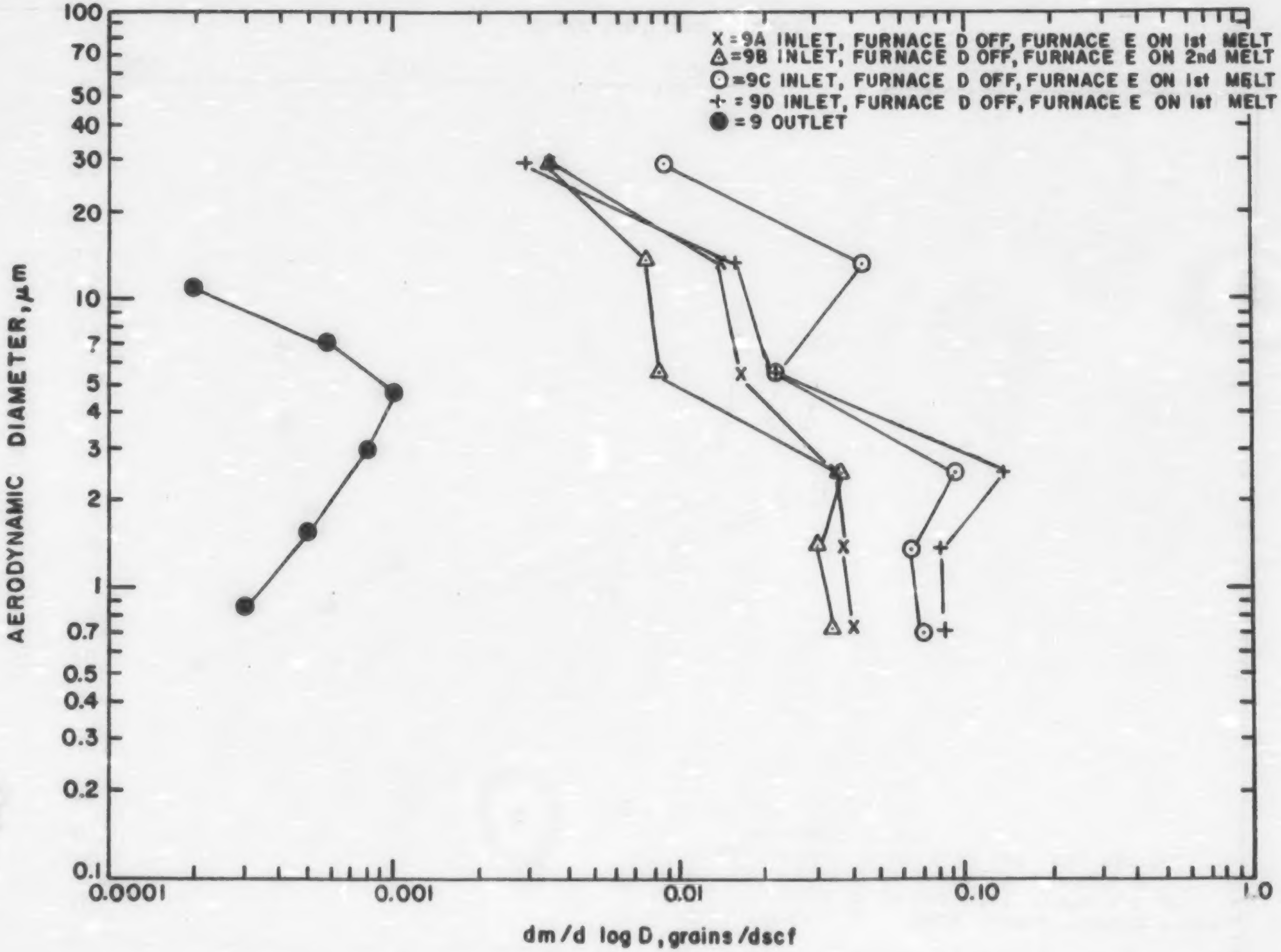


Figure B-9. Differential particle size distribution of baghouse influent and effluent during test 9, one furnace in operation

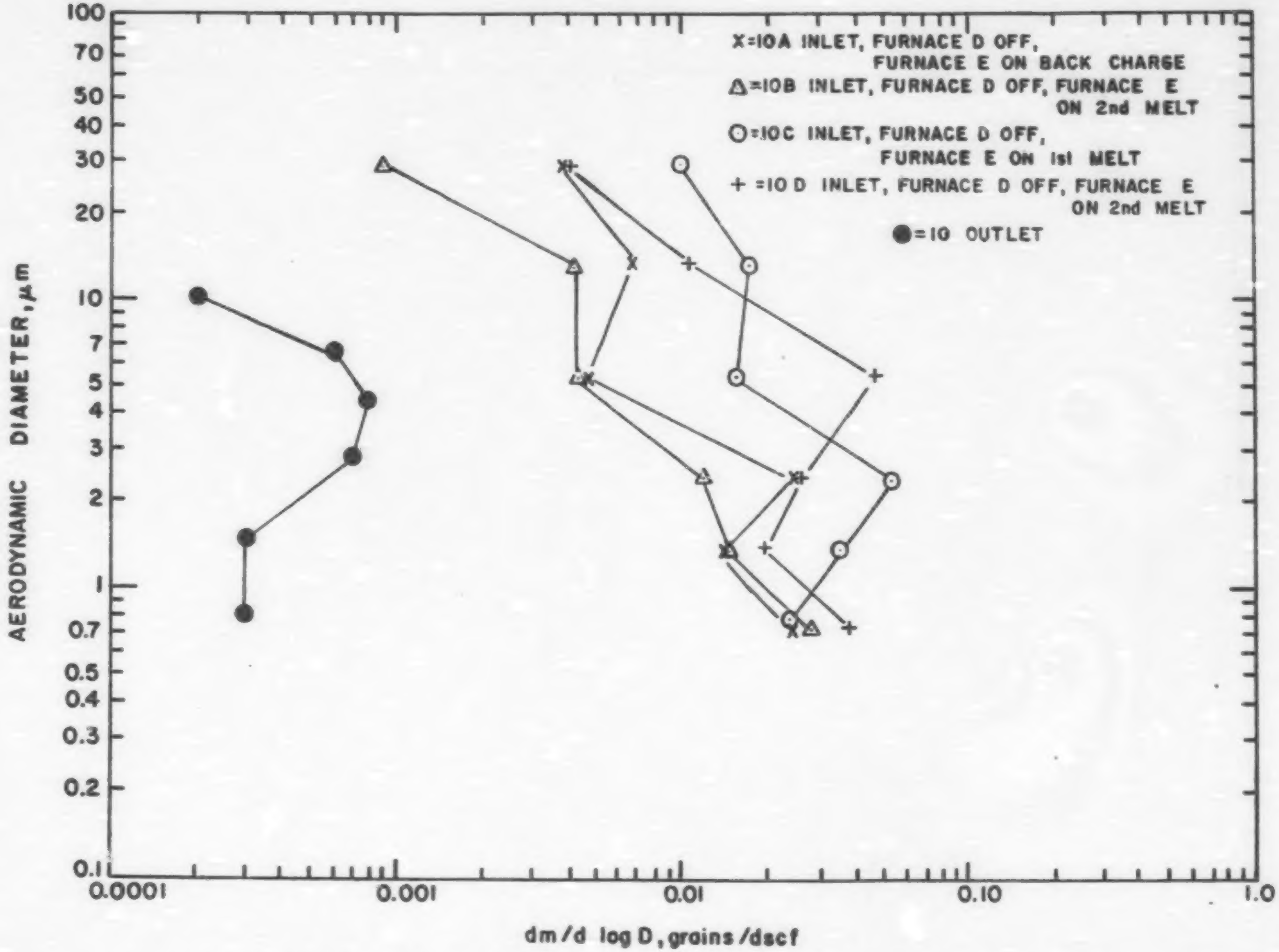


Figure B-10. Differential particle size distribution of baghouse influent and effluent during test 10, (one furnace in operation)

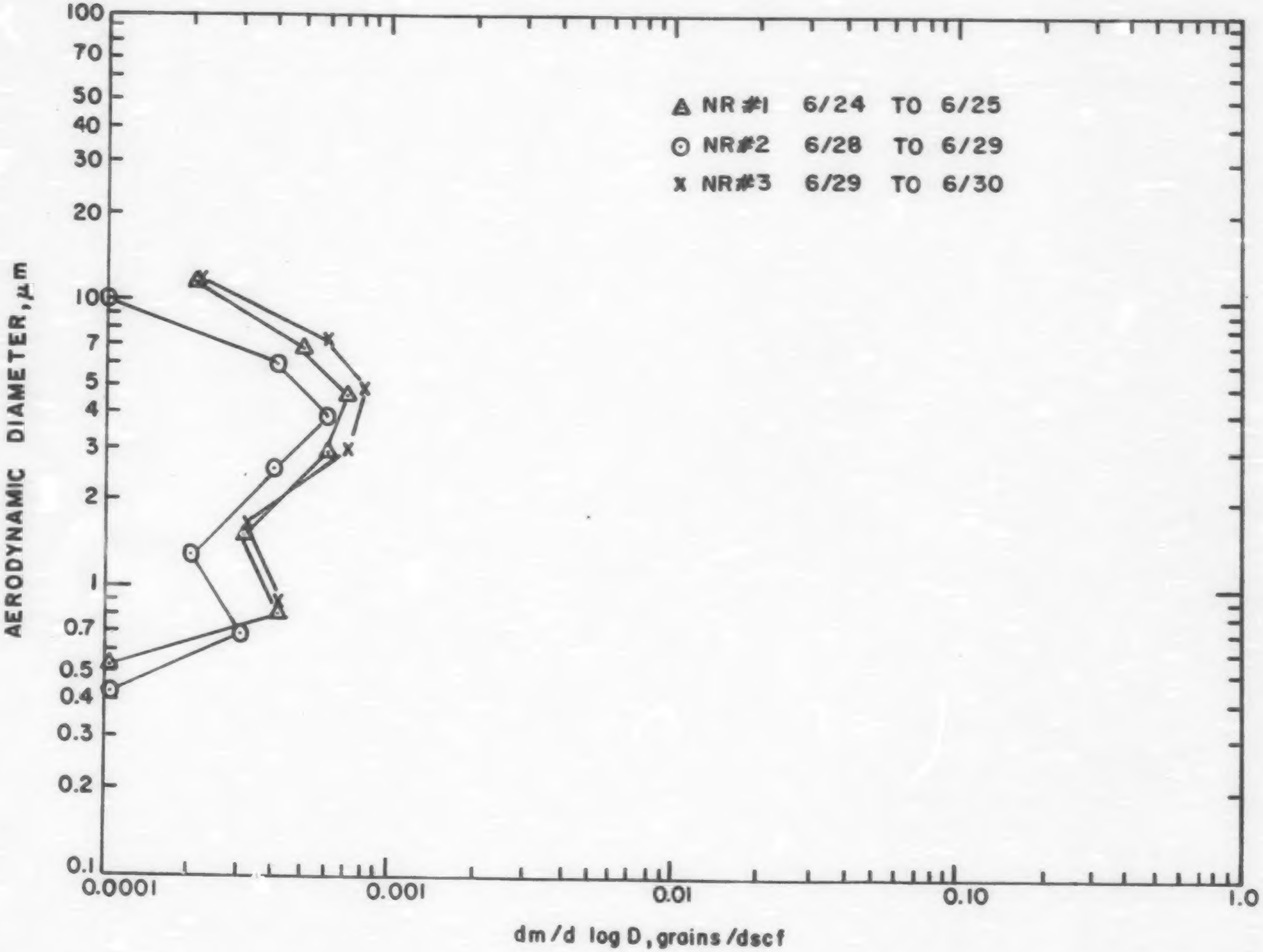


Figure B-11. Differential particle size distributions of baghouse effluent during three special tests during which the impactors were run unattended overnight with one furnace in operation

APPENDIX C

ANDERSEN IN-STACK IMPACTOR SUBSTRATE ANOMALOUS WEIGHT GAINS

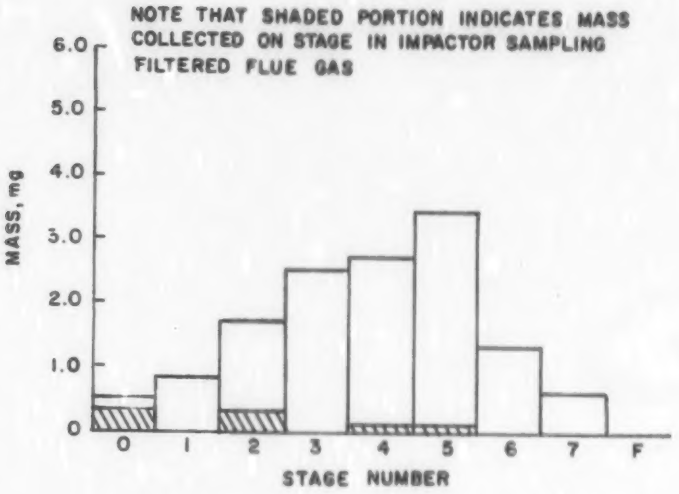


Figure C-1. Mass collected on stages of impactors sampling flue gas and filtered flue gas, outlet test 1

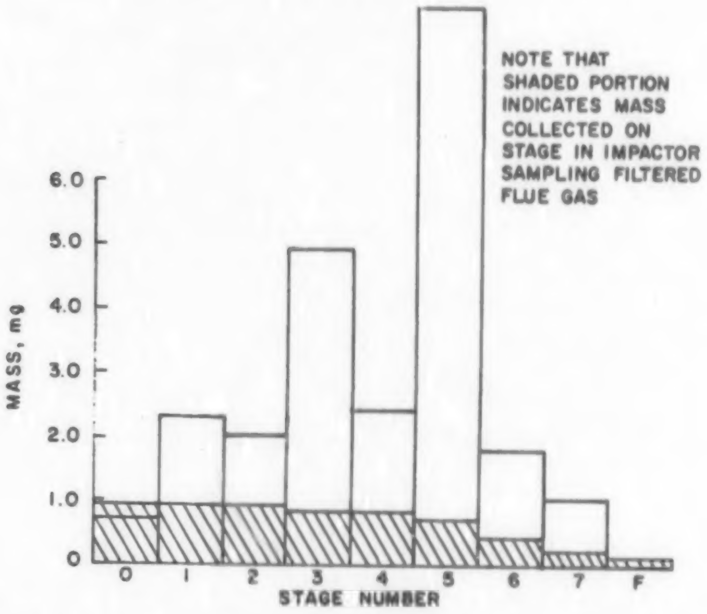


Figure C-2. Mass collected on stages of impactors sampling flue gas and filtered flue gas, outlet test 2

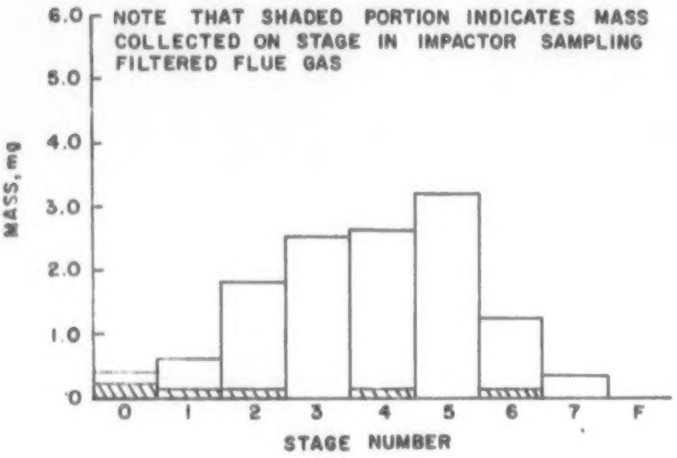


Figure C-3. Mass collected on stages of impactors sampling flue gas and filtered flue gas, outlet test 3

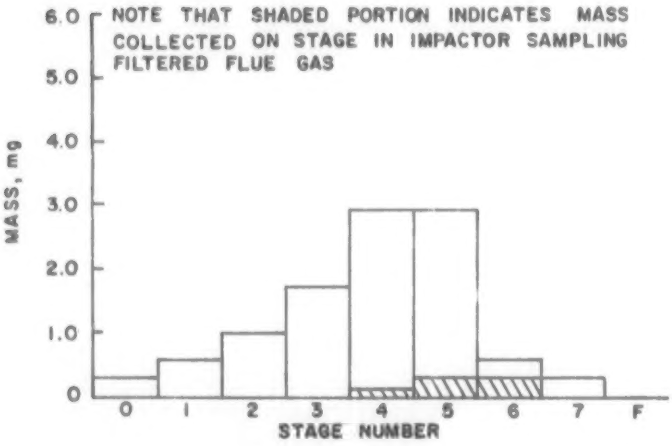


Figure C-4. Mass collected on stages of impactors sampling flue gas and filtered flue gas, outlet test 4

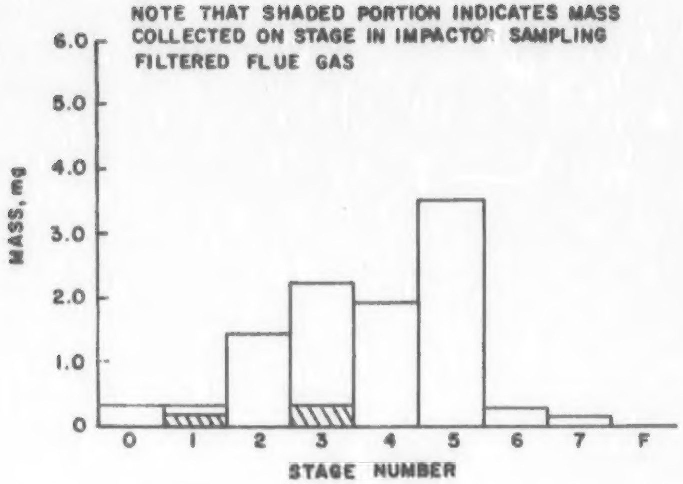


Figure C-5. Mass collected on stages of impactors sampling flue gas and filtered flue gas, outlet test 5

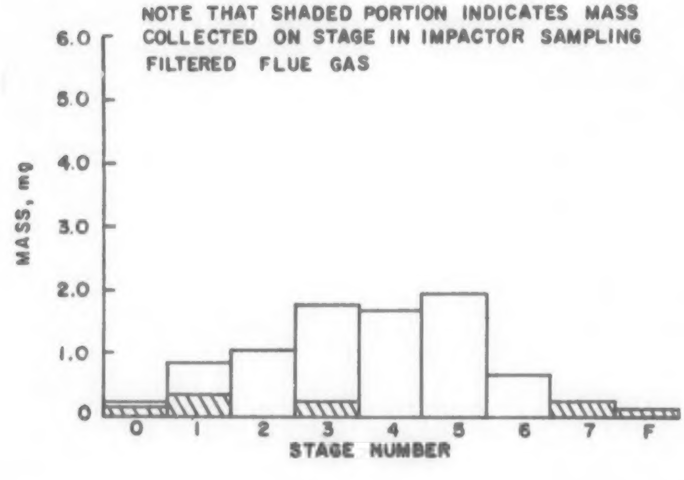


Figure C-6. Mass collected on stages of impactors sampling flue gas and filtered flue gas, outlet test 6

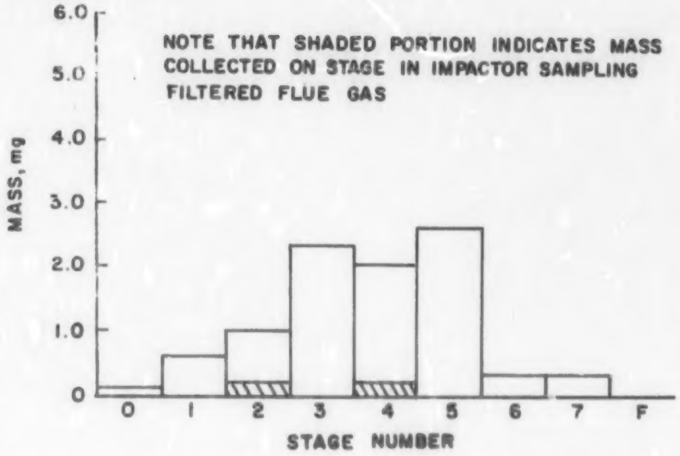


Figure C-7. Mass collected on stages of impactors sampling flue gas and filtered flue gas, outlet test 7

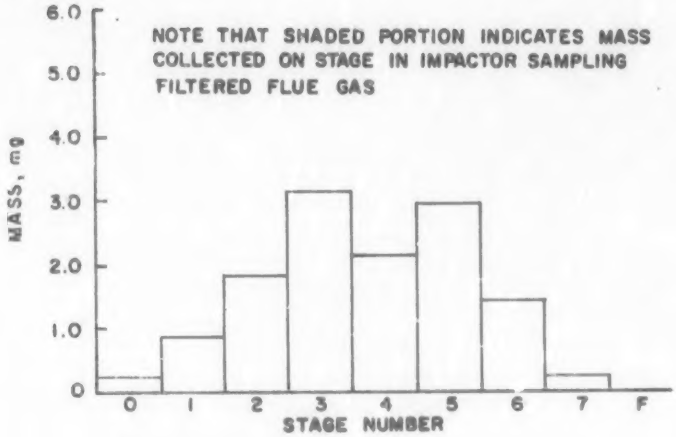


Figure C-8. Mass collected on stages of impactors sampling flue gas and filtered flue gas, outlet test 8

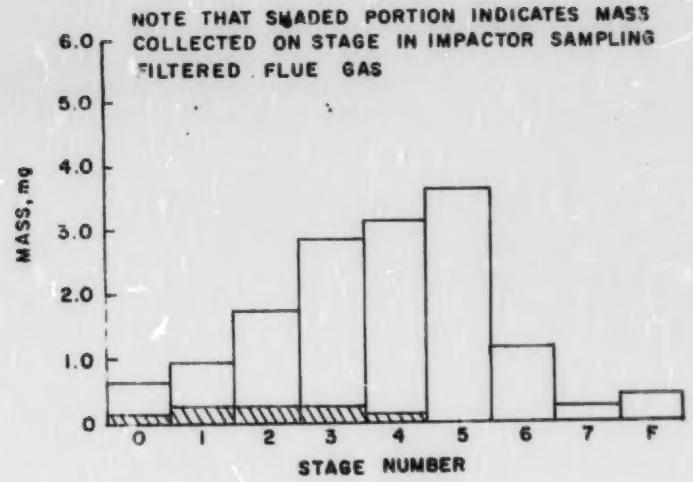


Figure C-9. Mass collected on stages of impactors sampling flue gas and filtered flue gas, outlet test 9

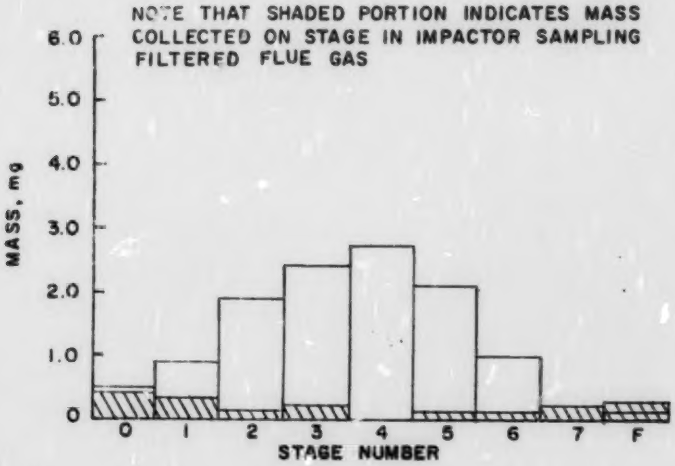


Figure C-10. Mass collected on stages of impactors sampling flue gas and filtered flue gas, outlet test 10

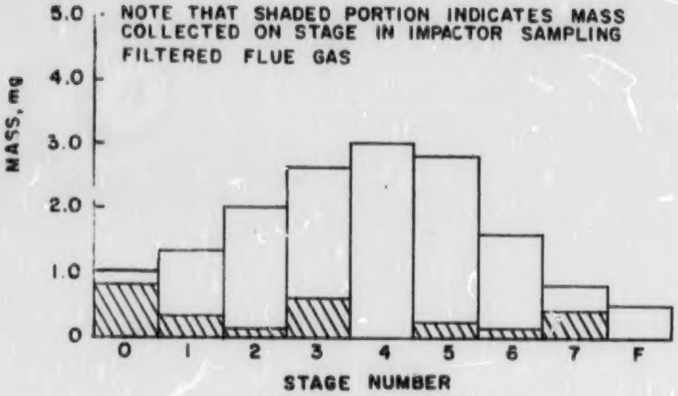


Figure C-11. Mass collected on stages of impactors sampling flue gas and filtered flue gas, outlet night run 1 (6/24 - 25/76)

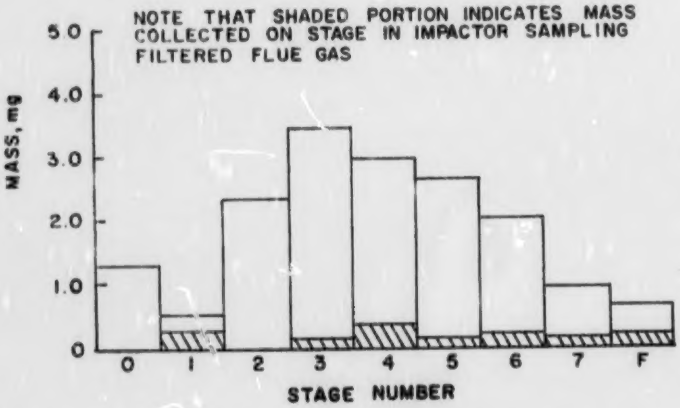


Figure C-12. Mass collected on stages of impactors sampling flue gas and filtered flue gas, outlet night run 3 (6/29 - 30/76)

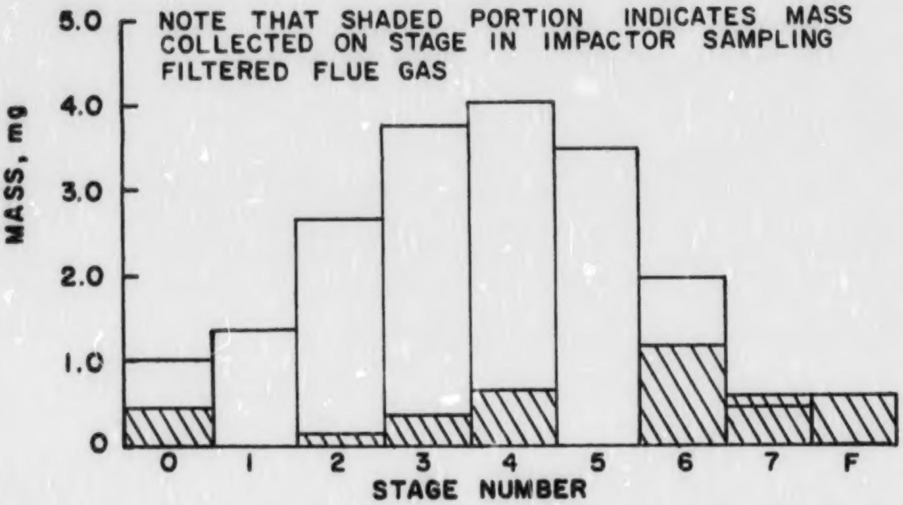


Figure C-13. Mass collected on stages of impactors sampling flue gas and filtered flue gas, outlet night run 3 (6/29 - 30/76)

APPENDIX D

CALCULATOR INPUTS/OUTPUTS FOR TOTAL MASS MEASUREMENTS

HP 65 DATA FORM R.A.C TRAIN.

INLET x

DATE 6/19/76 OUTLET ______ Run # 1

INPUT		OUTPUT	
Δh" H_2O	0.364	Vw^{STD} (ML)	1.09
Vcl (ML)	22.9	Vm^{STD} (Ft^3)	81.73
Vm (Ft^3)	84.322	Cs $^{grn}/Ft^3$)	0.1506
Tm (°R)	550	% H_2O	1.31
Pb ("HG)	30.09	% Dry Gas	98.69
Mn (mg)	799.1	M.W. (wet)	28.77
% CO_2	1.50 } from Run #2	D. ($^{lbs}/Ft^3$)	0.0743
% O_2	17.3 } from Run #2	% E.A.	479.35
% CO	0.80 } from Run #2	V (FPM)	4306
TSTK (°R)	567	Q^{STD}_{Dry} (Ft^3)	164,406
Ps ("H_2O)	4.5	Wp (^{lbs}Part/hr.)	212.17
$PV^{1/2}$	1.174	I	102.35
K	0.8592		
Θ(min)	240		
An (Ft^2)	0.000085		
Area Duct (Ft^2)	41.64		

HP 65 DATA FORM R.A.C TRAIN.

INLET ____________

DATE 6/19/76

OUTLET X

Run # 1

INPUT		**OUTPUT**	
Δh" H_2O	2.235	Vw^{STD} (ML)	4.61
Vcl (ML)	97.2	Vm^{STD} (Ft^3)	202.99
Vm (Ft^3)	213.044	Cs^{grn}/Ft^3)	0.0017
Tm (^oR)	562	% H_2O	2.22
Pb ("HG)	30.09	% Dry Gas	97.78
Mn (mg)	22.8	M.W. (wet)	28.67
% CO_2	1.50	D. ($^{lbs}/Ft^3$)	0.0683
% O_2	17.3	% E.A.	479.4
% CO	0.80	V (FPM)	2640
TSTK (^oR)	580	Q^{STD}_{Dry} (Ft^3)	67,046
Ps ("H_2O)	0	Wp (^{lbs} Part/hr.)	0.994
$PV^{\frac{1}{2}}$	0.740	I	105.2
K	0.85		
Θ(min)	240		
An (Ft^2)	0.000341		
Area Duct (Ft^2)	28.46		

from Run #2

$$\text{wt. eff, \%} = \left(\frac{C_{IN} - C_{OUT}}{C_{IN}}\right) 10^2 = \left(1 - \frac{C_{out}}{C_{IN}}\right) 10^2$$

wt. Penetration, % = 100 − eff, %

HP 65 DATA FORM R.A.C TRAIN.

INLET x

DATE 6/20/76

OUTLET

Run # 2

INPUT		**OUTPUT**	
$\Delta h''$ H_2O	0.373	Vw^{STD} (ML)	1.78
Vcl (ML)	37.5	Vm^{STD} (Ft^3)	123.62
Vm (Ft^3)	128.533	Cs^{grn}/Ft^3)	0.1438
Tm (^oR)	555	% H_2O	1.42
Pb ("HG)	30.13	% Dry Gas	98.58
Mn (mg)	1154.5	M.W. (wet)	28.78
% CO_2	1.5	D. ($^{lbs}/Ft^3$)	0.0666
% O_2	17.3	% E.A.	479.35
% CO	0.8	V (FPM)	4438
TSTK (^oR)	591	Q^{STD}_{Dry} (Ft^3)	166,623
Ps ("H_2O)	4.5	Wp (^{lbs} Part/hr.)	205,41
$PV^{\frac{1}{2}}$	1.215	I	102.44
K	0.8592		
Θ(min)	360		
An (Ft^2)	0.000085		
Area Duct (Ft^2)	42.64		

HP 65 DATA FORM R.A.C TRAIN.

INLET ________

DATE 6/30/76 OUTLET x Run # 2

INPUT		**OUTPUT**	
$\Delta h''$ H_2O	2.184	Vw^{STD} (ML)	4.50
Vcl (ML)	95	Vm^{STD} (Ft^3)	300.78
Vm (Ft^3)	310.445	Cs^{grn}/Ft^3)	0.0021
Tm (°R)	553	% H_2O	1.47
Pb ("HG)	30.13	% Dry Gas	98.53
Mn (mg)	41.9	M.W. (wet)	[illegible]
% CO_2	1.5 } from inlet	D. ($^{lbs}/Ft^3$)	0.0674
% O_2	17.3 } from inlet	% E.A.	479.35
% CO	0.8 } from inlet	V (FPM)	36[illegible]
TSTK (°R)	590	Q_{Dry}^{STD} (Ft^3)	66,[illegible]
Ps ("H_2O)	0	Wp (^{lbs} Part/hr.)	1.[illegible]
$PV^{\frac{1}{2}}$	0.732	I	[illegible]
K	0.85		
Θ(min)	360		
An (Ft^2)	0.000341		
Area Duct (Ft^2)	18.26		

HP 65 DATA FORM R.A.C TRAIN.

INLET X

DATE 6/21/76

OUTLET

Run # 3

INPUT

$\Delta h''$ H_2O	0.367
Vcl (ML)	40
Vm (Ft^3)	130.473
Tm (^oR)	562
Pb ("HG)	30.08
Mn (mg)	484.2
% CO_2	1.0
% O_2	18.4
% CO	0.4
TSTK (^oR)	600
Ps ("H_2O)	4.5
$PV^{\frac{1}{2}}$	1.133
K	0.8592
Θ(min)	360
An (Ft^2)	0.000085
Area Duct (Ft^2)	41.64

OUTPUT

Vw^{STD} (ML)	1.90
Vm^{STD} (Ft^3)	123.72
Cs^{grn}/Ft^3)	0.0603
% H_2O	1.51
% Dry Gas	98.49
M.W. (wet)	28.73
D. ($^{lbs}/Ft^3$)	0.0654
% E.A.	707.40
V (FPM)	4177
Q^{STD}_{Dry} (Ft^3)	154,056
Wp (^{lbs} Part/hr.)	79.59
I	110.88

HP 65 DATA FORM R.A.C TRAIN.

INLET ______

DATE 6/21/76 OUTLET X Run # 3

INPUT		OUTPUT	
Δh" H_2O	3.247	Vw^{STD} (ML)	4.74
Vcl (ML)	100	Vm^{STD} (Ft^3)	301.83
Vm (Ft^3)	316.860	Cs^{grn}/Ft^3)	0.0012
Tm (°R)	562	% H_2O	1.55
Pb ("HG)	30.08	% Dry Gas	98.45
Mn (mg)	22.8	M.W. (wet)	28.67
% CO_2	1.0	D. ($^{lbs}/Ft^3$)	0.0667
% O_2	17.0	% E.A.	351.6
% CO	0.5	V (FPM)	2658
TSTK (°R)	592	Q^{STD}_{Dry} (Ft^3)	66,558
Ps ("H_2O)	0	Wp (^{lbs} Part/hr.)	0.664
$PV^{\frac{1}{2}}$	0.737	I	105.1
K	0.85		
Θ(min)	360		
An (Ft^2)	0.000341		
Area Duct (Ft^2)	[illegible].26		

HP 65 DATA FORM R.A.C TRAIN.

INLET X

DATE 6/22/76 OUTLET ____ Run # 4

INPUT		**OUTPUT**	
Δh" H_2O	0.365	Vw^{STD} (ML)	3.18
Vcl (ML)	67	Vm^{STD} (Ft^3)	123.36
Vm (Ft^3)	130.78	Cs^{grn}/Ft^3)	0.0729
Tm (^oR)	564	% H_2O	2.51
Pb ("HG)	30.03	% Dry Gas	97.49
Mn (mg)	584.3	M.W. (wet)	28.54
% CO_2	0.80	D. ($^{lbs}/Ft^3$)	0.0662
% O_2	17.1	% E.A.	421.38
% CO	0.80	V (FPM)	4130
TSTK (^oR)	588	Q^{STD}_{Dry} (Ft^3)	153,606
Ps ("H_2O)	4.5	Wp (^{lbs}Part/hr.)	96.04
$PV^{1/2}$	1.127	I	110.88
K	0.8592		
Θ(min)	360		
An (Ft^2)	0.000085		
Area Duct (Ft^2)	42.64		

HP 65 DATA FORM R.A.C TRAIN.

INLET ________

DATE 6/22/76

OUTLET X

Run # 4

INPUT

Δh" H_2O 2.145

Vcl (ML) 97.8

Vm (Ft^3) 312.552

Tm (°R) 561

Pb ("HG) 30.03

Mn (mg) 31.8

% CO_2 0.80

% O_2 17.9

% CO 0.60

TSTK (°R) 586

Ps ("H_2O) 0

PV$^{\frac{1}{2}}$ 0.737

K 0.85

O(min) 360

An (Ft^2) 0.000341

Area Duct (Ft^2) 28.16

OUTPUT

Vw^{STD} (ML) 4.64

Vm^{STD} (Ft^3) 297.69

Cs^{grn}/Ft^3) 0.001[illegible]

% H_2O 1.53

% Dry Gas 98.47

M.W. (wet) 28.67

D. ($^{lbs}/Ft^3$) 0.0674

% E.A. 541.57

V (FPM) 2810

Q $^{STD}_{Dry}$ (Ft^3) 65,[illegible]

Wp $^{(lbs}$Part/hr.) 0.[illegible]

I 114.6

HP 65 DATA FORM R.A.C TRAIN.

INLET X

DATE 6/23/76 OUTLET ______ Run # 5

INPUT		**OUTPUT**	
Δh" H_2O	0.365	Vw^{STD} (ML)	3.37
Vcl (ML)	71	Vm^{STD} (Ft^3)	123.82
Vm (Ft^3)	130.913	Cs^{grn}/Ft^3)	0.0650
Tm (°R)	561	% H_2O	2.65
Pb ("HG)	29.95	% Dry Gas	97.35
Mn (mg)	522.5	M.W. (wet)	28.63
% CO_2	1.4	D. ($^{lbs}/Ft^3$)	0.0657
% O_2	17.5	% E.A.	529.04
% CO	0.90	V (FPM)	4146
TSTK (°R)	592	Q $^{STD}_{Dry}$ (Ft^3)	152,550
Ps ("H_2O)	4.5	Wp (^{lbs} Part/hr.)	84.98
$PV^{\frac{1}{2}}$	1.128	I	112.05
K	0.8592		
Θ(min)	360		
An (Ft^2)	0.000085		
Area Duct (Ft^2)	42.64		

HP 65 DATA FORM R.A.C TRAIN.

INLET ____________

DATE 5/13/76 OUTLET X Run # 5

INPUT		OUTPUT	
$\Delta h''$ H_2O	2.325	Vw^{STD} (ML)	6.53
Vcl (ML)	131.4	Vm^{STD} (Ft^3)	306.67
Vm (Ft^3)	319.82	Cs ($^{grn}/Ft^3$)	0.0015
Tm (^oR)	556	% H_2O	1.99
Pb ("HG)	29.45	% Dry Gas	98.01
Mn (mg)	29.1	M.W. (wet)	28.65
% CO_2	1.20	D. ($^{lbs}/Ft^3$)	0.0667
% O_2	17.7	% E.A.	535.06
% CO	0.60	V (FPM)	872
TSTK (^oR)	591	Q^{STD}_{Dry} (Ft^3)	67,684
Ps ("H_2O)	0	Wp (^{lbs} Part/hr.)	0.5478
$PV^{1/2}$	0.754	I	105.0
K	0.85		
Θ(min)	360		
An (Ft^2)	0.000341		
Area Duct (Ft^2)	28.16		

Reproduced from
best available copy.

HP 65 DATA FORM R.A.C TRAIN.

INLET x

DATE 6/24/76

OUTLET

Run # 6

INPUT			**OUTPUT**	
Δh" H_2O	0.377		Vw^{STD} (ML)	4.12
Vcl (ML)	87		Vm^{STD} (Ft^3)	125.01
Vm (Ft^3)	132.08		Cs^{grn}/Ft^3)	0.0672
Tm (^oR)	561		% H_2O	5.19
Pb ("HG)	29.97		% Dry Gas	96.8
Mn (mg)	545.8		M.W. (wet)	28.57
% CO_2	1.4		D. ($^{lbs}/Ft^3$)	0.0654
% O_2	17.5	from outlet	% E.A.	508.06
% CO	0.70		V (FPM)	4223
TSTK (^oR)	594		Q^{STD}_{Dry} (Ft^3)	154,066
Ps ("H_2O)	4.5		Wp (^{lbs} Part/hr.)	88.79
$PV^{\frac{1}{2}}$	1.146		I	112.02
K	0.8592			
Θ(min)	360			
An (Ft^2)	0.000085			
Area Duct (Ft^2)	42.64			

HP 65 DATA FORM R.A.C TRAIN.

INLET ____________

DATE 5/24/76 OUTLET X Run # 6

INPUT		OUTPUT	
Δh" H_2O	2.407	Vw^{STD} (ML)	5.55
Vcl (ML)	117	Vm^{STD} (Ft^3)	294.48
Vm (Ft^3)	306.905	Cs^{grn}/Ft^3)	0.0013
Tm (°R)	556	% H_2O	1.85
Pb ("HG)	29.97	% Dry Gas	98.15
Mn (mg)	24.7	M.W. (wet)	28.72
% CO_2	1.4	D. ($^{lbs}/Ft^3$)	0.0[illegible]71
% O_2	17.5	% E.A.	[illegible]
% CO	0.70	V (FPM)	2661
TSTK (°R)	589	Q $^{STD}_{Dry}$ (Ft^3)	66,533
Ps ("H_2O)	0	Wp (^{lbs} Part/hr.)	0.7[illegible]
$PV^{\frac{1}{2}}$	0.739	I	102.53
K	0.85		
Θ(min)	360		
An (Ft^2)	0.000341		
Area Duct (Ft^2)	28.16		

HP 65 DATA FORM R.A.C TRAIN.

INLET X

DATE 6/25/76 OUTLET ______ Run # 7

INPUT

$\Delta h''$ H_2O	0.375
Vcl (ML)	62
Vm (Ft^3)	131.233
Tm (^oR)	554
Pb ("HG)	30.01
Mn (mg)	552.2
% CO_2	0.60
% O_2	18.8
% CO	0.80
TSTK (^oR)	590
Ps ("H_2O)	4.5
$PV^{\frac{1}{2}}$	1.133
K	0.8592
Θ(min)	360
An (Ft^2)	0.000085
Area Duct (Ft^2)	42.64

OUTPUT

Vw^{STD} (ML)	2.94
Vm^{STD} (Ft^3)	125.94
Cs^{grn}/Ft^3)	0.0615
% H_2O	2.28
% Dry Gas	97.72
M.W. (wet)	28.60
D. ($^{lbs}/Ft^3$)	0.0660
% E.A.	985.43
V (FPM)	4156
Q^{STD}_{Dry} (Ft^3)	154,311
Wp (^{lbs}Part/hr.)	89.31
I	112.68

HP 65 DATA FORM R.A.C TRAIN.

INLET ____________

DATE 6/25/76 OUTLET X Run # 7

INPUT		**OUTPUT**	
$\Delta h''\ H_2O$	2.210	Vw^{STD} (ML)	6.57
Vcl (ML)	139	Vm^{STD} (Ft^3)	300.11
$\dot{V}m$ (Ft^3)	308,510	$Cs^{grn}/Ft^3)$	0.0011
Tm (^oR)	549	% H_2O	2.15
Pb ("HG)	30.01	% Dry Gas	97.85
Mn (mg)	21.9	M.W. (wet)	28.63
% CO_2	0.70	D. $(^{lbs}/Ft^3)$	0.0074
% O_2	18.9	% E.A.	1036.04
% CO	0.70	V (FPM)	2674
TSTK (^oR)	585	Q^{STD}_{Dry} (Ft^3)	66,0[illegible]
Ps $("H_2O)$	0	Wp $(^{lbs}$ Part/hr.)	[illegible]
$PV^{\frac{1}{2}}$	0.737	I	104.35
K	0.85		
Θ(min)	360		
An (Ft^2)	0.000341		
Area Duct (Ft^2)	28.26		

HP 65 DATA FORM R.A.C TRAIN.

INLET x

DATE 6/28/76 OUTLET Run # 8

INPUT

$\Delta h''\ H_2O$ 0.42

Vcl (ML) 53.4

Vm (Ft^3) 139.196

Tm (^oR) 566

Pb ("HG) 30.16

Mn (mg) 628.3

% CO_2 0.70

% O_2 19.9

% CO 0.60

TSTK (^oR) 587

Ps ("H_2O) 4.5

$PV^{\frac{1}{2}}$ 1.211

K 0.8592

Θ(min) 360

An (Ft^2) 0.000085

Area Duct (Ft^2) 42.64

OUTPUT

Vw^{STD} (ML) 2.53

Vm^{STD} (Ft^3) 131.42

Cs^{grn}/Ft^3) 0.0736

% H_2O 1.89

% Dry Gas 98.11

M.W. (wet) 28.70

D. ($^{lbs}/Ft^3$) 0.0669

% E.A. 3249.33

V (FPM) 4412

Q^{STD}_{Dry} (Ft^3) 166,142

Wp (^{lbs} Part/hr.) 104.85

I 109.23

HP 65 DATA FORM R.A.C TRAIN.

INLET ____________

OUTLET ___x___

Run # ___8___

DATE 6/28/76

INPUT

$\Delta h''$ H_2O	2.667
Vcl (ML)	166.3
Vm (Ft^3)	337.635
Tm (^oR)	573
Pb ("HG)	30.16
Mn (mg)	33.1
% CO_2	0.60
% O_2	19.8
% CO	0.50
TSTK (^oR)	588
Ps ("H_2O)	0
$PV^{\frac{1}{2}}$	0.801
K	0.85
Θ(min)	360
An (Ft^2)	0.000341
Area Duct (Ft^2)	28.16

OUTPUT

Vw^{STD} (ML)	7.98
Vm^{STD} (Ft^3)	316.60
Cs^{grn}/Ft^3)	0.0016
% H_2O	2.43
% Dry Gas	97.57
M.W. (wet)	28.64
D. ($^{lbs}/Ft^3$)	0.0074
% E.A.	2349
V (FPM)	2877
Q^{STD}_{Dry} (Ft^3)	74,087
Wp (^{lbs}Part/hr.)	0.9949
I	101.86

HP 65 DATA FORM R.A.C TRAIN.

INLET X

DATE 6/29/76 OUTLET ______ Run # 9

INPUT

$\Delta h''$ H_2O	0.370
Vcl (ML)	62
Vm (Ft^3)	131,282
Tm ($^\circ R$)	565
Pb ("HG)	30.06
Mn (mg)	494.5
% CO_2	0.40
% O_2	19.4
% CO	1.00
TSTK ($^\circ R$)	615
Ps ("H_2O)	4.5
$PV^{\frac{1}{2}}$	1.134
K	0.8592
Θ(min)	360
An (Ft^2)	0.000085
Area Duct (Ft^2)	42.64

OUTPUT

Vw^{STD} (ML)	2.94
Vm^{STD} (Ft^3)	123.74
Cs^{grn}/Ft^3)	0.0615
% H_2O	2.32
% Dry Gas	97.68
M.W. (wet)	28.59
D. ($^{lbs}/Ft^3$)	0.0634
% E.A.	1873.51
V (FPM)	4244
Q^{STD}_{Dry} (Ft^3)	151,374
Wp (^{lbs} Part/hr.)	79.85
I	113.86

HP 65 DATA FORM R.A.C TRAIN.

INLET ____________

DATE 6/29/76 OUTLET X Run # 9

INPUT

$\Delta h''\ H_2O$	2.319
Vcl (ML)	161
Vm (Ft^3)	322.091
Tm (^oR)	570
Pb ("HG)	30.06
Mn (mg)	28.1
% CO_2	0.50
% O_2	19.4
% CO	0.60
TSTK (^oR)	593
Ps ("H_2O)	0
$PV^{\frac{1}{2}}$	0.756
K	0.85
Θ(min)	360
An (Ft^2)	0.000341
Area Duct (Ft^2)	28.26

OUTPUT

Vw^{STD} (ML)	7.63
Vm^{STD} (Ft^3)	302.36
Cs^{grn}/Ft^3)	0.0414
% H_2O	2.46
% Dry Gas	97.54
M.W. (wet)	28.59
D. ($^{lbs}/Ft^3$)	0.0665
% E.A.	1482.9
V (FPM)	2734
Q_{Dry}^{STD} (Ft^3)	67,658
Wp (^{lbs}Part/hr.)	0.8300
I	103.56

HP 65 DATA FORM R.A.C TRAIN.

INLET X

DATE 6/30/76 OUTLET ________ Run # 10

INPUT		OUTPUT	
$\Delta h''\ H_2O$	3.794	Vw^{STD} (ML)	5.56
Vcl (ML)	117.2	Vm^{STD} (Ft^3)	351.34
Vm (Ft^3)	375.263	Cs^{grn}/Ft^3)	0.0617
Tm (^oR)	573	% H_2O	1.56
Pb ("HG)	30.03	% Dry Gas	98.44
Mn (mg)	1407.1	M.W. (wet)	28.68
% CO_2	0.50	D. ($^{lbs}/Ft^3$)	0.0658
% O_2	19.3	% E.A.	1816.16
% CO	1.10	V (FPM)	4433
TSTK (^oR)	594	Q^{STD}_{Dry} (Ft^3)	157,354
Ps ("H_2O)	4.5	Wp (^{lbs}Part/hr.)	83.19
$PV^{\frac{1}{2}}$	1.152	I	310.88
K	0.8592		
Θ(min)	360		
An (Ft^2)	0.000085		
Area Duct (Ft^2)	42.64		

HP 65 DATA FORM R.A.C TRAIN.

INLET ____

DATE 6/30/76 OUTLET X Run # 10

INPUT		OUTPUT	
Δh" H_2O	2.240	Vw^{STD} (ML)	6.34
Vc. (ML)	133.8	Vm^{STD} (Ft^3)	29.56
Vm (Ft^3)	313.594	Cs ($^{grn}/Ft^3$)	0.0012
Tm (°R)	567	% H_2O	2.10
Pb ("HG)	30.03	% Dry Gas	97.90
Mn (mg)	22.7	M.W. (wet)	28.70
% CO_2	0.80	D. ($^{lbs}/Ft^3$)	0.0670
% O_2	20.0	% E.A.	2632
% CO	0.20	V (FPM)	2672
TSTK (°R)	590	Q $^{STD}_{Dry}$ (Ft^3)	66,654
Ps ("H_2O)	0	Wp (^{lbs} Part/hr.)	0.6757
$PV^{\frac{1}{2}}$	0.742	I	102.74
K	0.85		
Θ(min)	360		
An (Ft^2)	0.000341		
Area Duct (Ft^2)	28.26		

APPENDIX E

CALCULATOR INPUTS/OUTPUTS FOR INERTIAL IMPACTOR MEASUREMENTS

ANDERSEN IMPACTOR

Date 6/19/76 Run # 1A

Sample volume at STP (ft^3) = 5.6393

Moisture (%) =

Concentration ($grains/ft^3$) = 1.9185

Impactor flow rate (acfm) = 0.4039

Location INLET Furn D = 1st melt, Furn E = 2nd melt
Time 1917-1933
Orifice D
bar. press. ("Hg) = 30.09
Mw = 28.79
avg. Pm (-"Hg) = 2.025
avg. Tm (°F) = 79.5
H_2O (grams or %) = 1.31%
meter volume (ft^3) = 6.041
avg. Ps (+"H_2O) = 4.50
avg. Ts (°F) = 107
time (minutes) = 15
correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
TC#10	Probe & expander	0.0167	24.1329		75.8670		
	0						
30	1	0.0002	0.2890	40.8275	75.5780		
31	2	0.0004	0.5780	17.2063	75.0000	0.0029	26.5046
32	3	0.0031	4.4797	8.2812	70.5202	0.0270	11.9369
33	4	0.0065	9.3930	2.7847	61.1271	0.0380	4.8022
34	5	0.0134	19.3641	1.7547	41.7630	0.1852	2.2105
35	6	0.0137	19.7976	0.8657	21.9653	0.1237	1.2325
36	7	0.0104	15.0289	0.4636	6.9364	0.1063	0.6335
R-4	F	0.0048	6.9364				
	Total	0.0692					

ANDERSEN IMPACTOR

Date 6/19/76 Run # 1

Sample volume at STP (ft^3) = 259 0443

Moisture (%) = 1.8576

Concentration ($grains/ft^3$) = 0.0010

Impactor flow rate (acfm) = 0.5033

Location outlet East

Orifice E

bar. press. ("Hg) = 30.09

Mw = 28.69

avg. Pm (-"Hg) = 1.621

avg. Tm (°F) = 80

H_2O (grams or %) = 98.2

meter volume (ft^3) = 262.831

avg. Ps (±"H_2O) = 0

avg. Ts (°F) = 120

time (minutes) = 540

correction factor = 1

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	*% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC*12	Probe & expander	0.0031	18.6746		81.3253		
R162	0	0.0005	3.0120	13.6604	78.3132		
R161	1	0.0008	4.8192	8.5496	73.4939	0.0002	10.8070
R164	2	0.0017	10.2409	5.8120	63.2530	0.0006	7.0492
R163	3	0.0025	15.0602	3.9571	48.1927	0.0009	4.7957
R166	4	0.0027	16.2650	2.4440	31.9277	0.0008	3.1088
R165	5	0.0034	20.4819	1.0515	11.4457	0.0005	1.6031
R168	6	0.0013	7.8313	0.7065	3.6144	0.0004	0.8619
R167	7	0.0006	3.6144	0.4140	0.0000		
R-1	F	0.0000	0.0000				
	Total	0.0166					

ANDERSEN IMPACTOR

Date 6/20/76 Run # 2A

Sample volume at STP (ft^3) = 2.8026

Moisture (%) =

Concentration ($grains/ft^3$) = 0.0765

Impactor flow rate (acfm) = 0.3134

Location inlet

Time 1542 - 1552 Furn D: 2nd melt. E: 2nd melt.

Orifice D

bar. press. ("Hg) = 30.13

Mw = 28.78

avg. Pm (-"Hg) = 1.03

avg. Tm (°F) = 83

H_2O (grams or %) = 1.42 %

meter volume (ft^3) = 2.911

avg. Ps (±"H_2O) = 4.50

avg. Ts (°F) = 131

time (minutes) = 10

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
TC#14	Probe & expander	0.0048	35.0364		64.9635		
	0						
51	1	0.0004	2.9197	46.8768	62.0437		
52	2	0.0003	2.1897	19.7659	59.8570	0.0044	30.4395
53	3	0.0008	5.8394	9.520997	54.0145	0.0140	13.7182
54	4	0.0009	6.5693	3.2102	47.4452	0.0106	5.5285
55	5	0.0025	18.2481	2.0275	29.1970	0.0699	2.5513
56	6	0.0013	9.4890	1.0066	19.7080	0.0238	1.4286
57	7	0.0027	19.7080	0.5460	0.0000	0.0567	0.7413
?	F	NONE	0.0000				
	Total	0.0137					

ANDERSEN IMPACTOR

Date 6/20/76 Run # 28

Sample volume at STP (ft^3) = 2.7647

Moisture (%) =

Concentration ($grains/ft^3$) = 0.0911

Impactor flow rate (acfm) = 0.3092

Location IN let

Time 1711 – 1721 Furn D = tap
E = 1st melt

Orifice D

bar. press. ("Hg) = 30.13

Mw = 28.78

avg. Pm (-"Hg) = 1.60

avg. Tm (°F) = 83

H_2O (grams or %) = 1.42%

meter volume (ft^3) = 2.929

avg. Ps (±"H_2O) = 4.50

avg. Ts (°F) = 131

time (minutes) = 10

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC 16	Probe & expander	0.0053	32.9192		67.0807		
	0						
44	1	0.0004	2.4844	47.1979	64.5962		
45	2	0.0004	2.4844	19.9019	62.1118	0.0060	30.6485
46	3	0.0014	8.6956	9.5869	53.4161	0.0249	13.8130
47	4	0.0020	12.4223	3.2330	40.9937	0.0239	5.5673
48	5	0.0018	11.1801	2.0423	29.8136	0.0510	2.5696
49	6	0.0015	9.3167	1.0143	20.4968	0.0279	1.4393
50	7	0.0027	16.7701	0.5506	3.7267	0.0576	0.7473
34	F	0.0006	3.7267				
	Total	0.0161					

ANDERSEN IMPACTOR

Date 6/20/76 Run # 2

Sample volume at STP (ft^3) = 243.5957

Moisture (%) = 1.4174

Concentration (grains/ft^3) = 0.0017

Impactor flow rate (acfm) = 0.4982

Location outlet North

Orifice F
bar. press. ("Hg) = 30.13
Mw = 28.77
avg. Pm (-"Hg) = 1.634
avg. Tm (°F) = 80.3
H_2O (grams or %) = 73.0
meter volume (ft^3) = 257.100
avg. Ps (±"H_2O) = 0
avg. Ts (°F) = 130
time (minutes) = 540
correction factor = 1

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
TC*17	Probe & expander	0.0030	11.1524		88.8475		
R160	0	0.0007	2.6022	13.8194	86.2453		
R191	1	0.0023	8.5501	8.6490	77.6951	0.0007	10.9327
R158	2	0.0020	7.4349	5.8795	70.2602	0.0007	7.1310
R184	3	0.0049	18.2156	4.0028	52.0446	0.0018	4.8512
R156	4	0.0024	8.9219	2.4720	43.1226	0.0007	3.1456
R187	5	0.0087	32.3420	1.0632	10.7806	0.0015	1.6211
R154	6	0.0018	6.6914	0.7141	4.0892	0.0006	0.8713
R185	7	0.0010	3.7174	0.4184	0.3717	0.0002	0.5466
33	F	0.0001	0.3717				
	Total	0.0269					

ANDERSEN IMPACTOR

Date 6/21/76 **Run #** 3A

Sample volume at STP (ft^3) =

Moisture (%) =

Concentration (grains/ft^3) =

Impactor flow rate (acfm) =

Location inlet
Time 1802 - 1812 (1st melt)
Orifice D
bar. press. ("Hg) = 30.08
Mw = 28.73
avg. Pm (-"Hg) = 2.267
avg. Tm (^oF) = 86.5
H_2O (grams or %) = 1.51%
meter volume (ft^3) = 3.752
avg. Ps (+"H_2O) = 4.50
avg. Ts (^oF) = 140
time (minutes) = 10
correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#20	Probe & expander	0.0082					
	0						
11s'	1	$\bar{0}$.0007					
11	2	$\bar{0}$.0015					
12	3	$\bar{0}$.0006					
13	4	0.0006					
14	5	0.0042					
15	6	0.0035					
18	7	0.0006					
R14	F	0.0020					
	Total						

NG

ANDERSEN IMPACTOR

Date 6/21/76 Run # 38

Sample volume at STP (ft^3) =

Moisture (%) =

Concentration ($grains/ft^3$) =

Impactor flow rate (acfm) =

Location inlet

Time 1847- 1857 (end of 1st melt)

Orifice D

bar. press. ("Hg) = 30.08

Mw = 28.73

avg. Pm (-"Hg) = 2.033

avg. Tm (°F) = 84

H_2O (grams or %) = 1.51

meter volume (ft^3) = 5.987

avg. Ps (+"H_2O) = 4.50

avg. Ts (°F) = 140

time (minutes) = 10

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#21	Probe & expander	0.0045					
	0						
37	1	-0.0004					
38	2	-0.0012					
39	3	-0.0010		NG			
40	4	-0.0004					
41	5	0.0019					
42	6	-0.0004					
43	7	-0.0040					
R 15	F	0.0009					
	Total						

ANDERSEN IMPACTOR

Date 6/21/76 Run # 3

Location outlet North

Sample volume at STP (ft^3) = 2432492

Moisture (%) = 1.4000

Concentration ($grains/ft^3$) = 0.0009

Impactor flow rate (acfm) = 0.5000

Orifice F

bar. press. ("Hg) = 30.08

Mw = 28.67

avg. Pm (-"Hg) = 1.73

avg. Tm (°F) = 92.1

H_2O (grams or %) = 72.0

meter volume (ft^3) = 263.739

avg. Ps (±"H_2O) = 0

avg. Ts (°F) = 132

time (minutes) = 540

correction factor = 1

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#19	Probe & expander	0.0027	17.6470		82.3529		
R50	0	0.0004	2.6143	13.8113	79.7385		
R49	1	0.0006	3.9215	8.6437	75.8169	0.0001	10.9262
R52	2	0.0018	11.7647	5.8757	64.0522	0.0006	7.1266
R51	3	0.0025	16.3398	4.0001	47.7124	0.0009	4.8480
R54	4	0.0026	16.9934	2.4700	30.7189	0.0007	3.1433
R53	5	0.0032	20.9150	1.0620	9.8039	0.0005	1.6196
R56	6	0.0012	7.8431	0.7132	1.9607	0.0004	0.8703
R55	7	0.0003	1.9607	0.4176	0.0000	0.0000	0.5457
R11	F	0.0000	0.0000				
	Total	0.0153					

ANDERSEN IMPACTOR

Date 6/22/76 Run # 4A

Sample volume at STP (ft^3) =

Moisture (%) =

Concentration ($grains/ft^3$) =

Impactor flow rate (acfm) =

Location inlet

Orifice D

bar. press. ("Hg) = 30.03

Mw = 28.54

avg. Pm (-"Hg) = 1.425

avg. Tm (°F) = 88.5

H_2O (grams or %) = 2.51

meter volume (ft^3) = 4.599

avg. Ps (+"H_2O) = 4.50

avg. Ts (°F) = 168

time (minutes) = 15

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#26	Probe & expander	0.0063					
	0						
11s	1	0.0003					
11	2	-0.0006		NG			
12	3	-0.0018					
13	4	-0.0009					
14	5	0.0000					
15	6	0.0014					
18	7	0.0002					
R24	F	0.0000					
	Total						

ANDERSEN IMPACTOR

Date 6/22/76 Run # 4B

Sample volume at STP (ft^3) =

Moisture (%) =

Concentration ($grains/ft^3$) =

Impactor flow rate (acfm) =

Location inlet

Orifice D

bar. press. ("Hg) = 30.03

Mw = 28.54

avg. Pm (-"Hg) = 1.488

avg. Tm (°F) = 87

H_2O (grams or %) = 8.51

meter volume (ft^3) = 4.661

avg. Ps (+"H_2O) = 4.50

avg. Ts (°F) = 128

time (minutes) = 15

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC #29	Probe & expander	0.0030					
	0						
44	1	-0.0005					
45	2	-0.0003					
46	3	0.0003					
47	4	0.0004					
48	5	0.0016					
49	6	0.0024					
50	7	0.0026					
R 25	F	0.0031					
	Total						

NG

ANDERSEN IMPACTOR

Date 6/22/76 Run # 4

Sample volume at STP (ft^3) = 193.1705

Moisture (%) = 1.4446

Concentration ($grains/ft^3$) = 0.0009

Impactor flow rate (acfm) = 0.3937

Location outlet North

Orifice F

bar. press. ("Hg) = 30.03

Mw = 28.67

avg. Pm (-"Hg) = 1.413

avg. Tm (°F) = 91.9

H_2O (grams or %) = 59.0

meter volume (ft^3) = 205.880

avg. Ps (+"H_2O) = 0

avg. Ts (°F) = 136

time (minutes) = 540

correction factor = 1

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#28	Probe & expander	0.0012	10.4347		89.5652		
R 74	0	0.0003	2.6086	15.5181	86.9565		
R15	1	0.0006	5.2173	9.7185	81.7391	0.0002	12.2806
R22	2	0.0010	8.6956	6.6116	73.0434	0.0004	8.0159
R13	3	0.0017	14.7826	4.5060	58.2608	0.0008	5.4582
R20	4	0.0029	25.2173	2.7878	33.0434	0.0011	3.5443
R11	5	0.0029	25.2173	1.2057	7.8260	0.0006	1.8334
R18	6	0.0006	5.2173	0.8140	2.6086	0.0002	0.9907
R9	7	0.0003	2.6086	0.4824	0.0000	0.0001	0.6266
R23	F	0.0000	0.0000				
	Total	0.0115					

ANDERSEN IMPACTOR

Date 6/23/76 Run # 5A

Sample volume at STP (ft^3) =

Moisture (%) =

Concentration (grains/ft^3) =

Impactor flow rate (acfm) =

Location inlet

Orifice D

bar. press. ("Hg) = 29.95

Mw = 28.63

avg. Pm (-"Hg) = 1.367

avg. Tm (^{o}F) = 85

H_2O (grams or %) = 2.65

meter volume (ft^3) = 3.067

avg. Ps (+"H_2O) = 4.50

avg. Ts (^{o}F) = 132

time (minutes) = 10

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#22	Probe & expander	0.0045					
	0						
51	1	-0.0002					
52	2	-0.0002					
53	3	-0.0017					
54	4	-0.0003					
55	5	-0.0033					
56	6	-0.0011					
57	7	-0.0002					
R19	F	-0.0012					
	Total						

NG

ANDERSEN IMPACTOR

Date 6/23/76 Run # 5B

Sample volume at STP (ft^3) =

Moisture (%) =

Concentration (grains/ft^3) =

Impactor flow rate (acfm) =

Location inlet

Orifice D

bar. press. ("Hg) = 29.75

Mw = 28.63

avg. Pm (-"Hg) = 1.475

avg. Tm ($^\circ$F) = 96.25

H_2O (grams or %) = 2.65

meter volume (ft^3) = 3.990

avg. Ps (±"H_2O) = 4.50

avg. Ts ($^\circ$F) = 138

time (minutes) = 15

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
TC#24	Probe & expander	0.0065					
	0						
37	1	0.0002					
38	2	-0.0012					
39	3	-0.0002		NC			
40	4	-0.0001					
41	5	-0.0002					
42	6	0.0022					
43	7	0.0064					
R20	F	0.0046					
	Total						

ANDERSEN IMPACTOR

Date 6/23/76 Run # 5C

Sample volume at STP (ft^3) = 8.3555

Moisture (%) =

Concentration ($grains/ft^3$) = 0.0500

Impactor flow rate (acfm) = 0.3139

Location inlet

Time 1555–1625 (back charge)

Orifice D

bar. press. ("Hg) = 27.95

Mw = 28.63

avg. Pm (-"Hg) = 1.436

avg. Tm (°F) = 93.4

H_2O (grams or %) = 2.65 %

meter volume (ft^3) = 8.914

avg. Ps (±"H_2O) = 4.50

avg. Ts (°F) = 132

time (minutes) = 30

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#25	Probe & expander	0.0092	34.8484		65.1515		
	0						
30	1	0.0013	4.9242	46.8621	60.2272		
31	2	0.0000	0.0000	19.7594	60.2272	0.0000	30.4297
32	3	0.0006	2.2727	9.5175	57.9545	0.0035	13.7135
33	4	0.0012	4.5454	3.2087	53.4090	0.0048	5.5262
34	5	0.0037	14.0151	2.0264	39.3939	0.0351	2.5499
35	6	0.0041	15.5303	1.0058	23.8636	0.0255	1.4276
36	7	0.0037	14.0151	0.5453	9.8484	0.0264	0.7406
R6	F	0.0026	9.8484				
	Total	0.0264					

ANDERSEN IMPACTOR

Date 6/23/76 Run # 5

Sample volume at STP (ft^3) = 249.6224

Moisture (%) = 1.7830

Concentration (grains/ft^3) = 0.0008

Impactor flow rate (acfm) = 0.5144

Location outlet North

Orifice F

bar. press. ("Hg) = 29.95

Mw = 28.68

avg. Pm (-"Hg) = 1.681

avg. Tm (°F) = 92.7

H_2O (grams or %) = 94.1

meter volume (ft^3) = 270.664

avg. Ps (±"H_2O) = 0

avg. Ts (°F) = 131

time (minutes) = 540

correction factor = 1

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#23	Probe & expander	0.0040	28.7769		71.2230		
R48	0	0.0003	2.1582	13.6060	69.0647		
R23	1	0.0003	2.1582	8.5146	66.9064	0.0000	10.7633
R46	2	0.0014	10.0719	5.7873	56.8345	0.0005	7.0197
R21	3	0.0022	15.8273	3.9394	41.0071	0.0008	4.7748
R44	4	0.0019	13.6690	2.4321	27.3381	0.0005	3.0953
R19	5	0.0035	25.1798	1.0450	2.1582	0.0006	1.5942
R42	6	0.0002	1.4388	0.7014	0.7194	0.0000	0.8561
R17	7	0.0001	0.7194	0.4100	0.0000	0.0000	0.5363
R16	F	0.0000	0.0000				
	Total	0.0139					

ANDERSEN IMPACTOR

Date 6/24/76 Run # 6A
Sample volume at STP (ft^3) = 5.6115
Moisture (%) =
Concentration (grains/ft^3) = 0.0369
Impactor flow rate (acfm) = 0.3171

Location inlet
Time 1609–1629 (2nd melt, back charge ~ 1530)
Orifice D
bar. press. ("Hg) = 29.97
Mw = 28.58
avg. Pm (-"Hg) = 1.410
avg. Tm (°F) = 95.0
H_2O (grams or %) = 3.19%
meter volume (ft^3) = 5.961
avg. Ps (+"H_2O) = 4.50
avg. Ts (°F) = 134
time (minutes) = 20
correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
TC #32	Probe & expander	0.0041	31.5384		68.4615		
	0						
11S	1	0.0006	4.6153	46.6678	63.8461		
11	2	0.0003	2.3076	19.6768	61.5384	0.0022	30.3030
12	3	0.0006	4.6153	9.4772	56.9230	0.0053	13.6558
13	4	0.0012	9.2307	3.1944	47.6923	0.0072	5.5022
14	5	0.0015	11.5384	2.0170	36.1538	0.0213	2.5383
15	6	0.0030	23.0769	1.0006	13.0769	0.0279	1.4206
18	7	0.0017	13.0769	0.5421	0.0000	0.0181	0.7365
R29	F	0.0000	0.0000				
	Total	0.0130					

ANDERSEN IMPACTOR

Date 6/24/76 Run # 68

Sample volume at STP (ft^3) = 2.8313

Moisture (%) =

Concentration (grains/ft^3) = 0.0287

Impactor flow rate (acfm) = 0.3200

Location inlet

Time 1726 - 1736 (tap)

Orifice D

bar. press. ("Hg) = 29.97

Mw = 28.58

avg. Pm (-"Hg) = 1.870

avg. Tm (^{o}F) = 95.0

H_2O (grams or %) = 3.19 %

meter volume (ft^3) = 2.993

avg. Ps (±"H_2O) = 4.50

avg. Ts (^{o}F) = 134

time (minutes) = 10

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#30	Probe & expander	0.0014	27.4509		72.5490		
	0						
44	1	0.0004	7.8431	46.4560	64.7058		
45	2	0.0001	1.9607	19.5870	62.7450	0.0015	30.1651
46	3	0.0004	7.8431	9.4336	54.9019	0.0070	13.5933
47	4	0.0002	3.9215	3.1793	50.9803	0.0023	5.4766
48	5	0.0003	5.8823	2.0073	45.0980	0.0084	2.5262
49	6	0.0007	13.7254	0.9955	31.3725	0.0129	1.4136
50	7	0.0005	9.8039	0.5390	21.5686	0.0105	0.7325
R30	F	0.0011	21.5686				
	Total	0.0051					

ANDERSEN IMPACTOR

Date 6/24/76 Run # 6

Sample volume at STP (ft^3) = 242.4838

Moisture (%) = 1.6248

Concentration (grains/ft^3) = 0.0006

Impactor flow rate (acfm) = 0.4977

Location outlet East

Orifice E

bar. press. ("Hg) = 29.97

Mw = 28.72

avg. Pm (-"Hg) = 2.880

avg. Tm (^{o}F) = 90.0

H_2O (grams or %) = 83.3

meter volume (ft^3) = 268.510

avg. Ps (±"H_2O) = 0

avg. Ts (^{o}F) = 129

time (minutes) = 540

correction factor = 1

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
TC#33	Probe & expander	0.0026	25.0000		75.0000		
R-2	0	0.0001	0.9615	13.8172	74.0384		
R89	1	0.0008	7.6923	8.6477	66.3461	0.0002	10.9310
R4	2	0.0010	9.6153	5.8786	56.7307	0.0003	7.1300
R91	3	0.0017	16.3461	4.0023	40.3846	0.0006	4.8505
R6	4	0.0016	15.3846	2.4717	25.0000	0.0004	3.1452
R93	5	0.0019	18.2692	1.0631	6.7307	0.0003	1.6210
R8	6	0.0006	5.7692	0.7141	0.9615	0.0002	0.8713
R95	7	0.0000	0.0000	0.4184	0.9615	0.0000	0.5466
R28	F	0.0001	0.9615				
	Total	0.0104					

ANDERSEN IMPACTOR

6/24 to Night Run

Date 6/25 Run # NR #1

Location outlet North

Sample volume at STP (ft^3) = 350.4370

Moisture (%) = 2.0111

Concentration ($grains/ft^3$) = 0.0007

Impactor flow rate (acfm) = 0.5054

Orifice F

bar. press. ("Hg) = 29.97

Mw = 28.72

avg. Pm (-"Hg) = 1.475

avg. Tm (°F) = 89

H_2O (grams or %) = 149.0

meter volume (ft^3) = 373.570

avg. Ps (±"H_2O) = 0

avg. Ts (°F) = 134

time (minutes) = 775

correction factor = 1

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
TC#35	Probe & expander	0.0017	9.8837		90.1162		
162	0	0.0010	5.8139	13.7534	84.3023		
153	1	0.0013	7.5581	8.6071	76.7441	0.0002	10.8801
164	2	0.0020	11.6279	5.8505	65.1162	0.0005	7.0962
155	3	0.0026	15.1162	3.9827	50.0000	0.0007	4.8271
166	4	0.0030	17.4418	2.4590	32.5581	0.0006	3.1294
157	5	0.0028	16.2790	1.0569	16.2790	0.0003	1.6121
168	6	0.0016	9.3023	0.7095	6.9767	0.0004	0.8660
159	7	0.0008	4.6511	0.4151	2.3255	0.0001	0.5427
30	F	0.0004	2.3255				
	Total	0.0172					

ANDERSEN IMPACTOR

Date 6/25/76 Run # 7A

Sample volume at STP (ft^3) = 7.2027

Moisture (%) =

Concentration ($grains/ft^3$) = 0.0664

Impactor flow rate (acfm) = 0.3230

Location inlet
Time 1620 – 1645 (alloy addition)
Orifice D
bar. press. ("Hg) = 30.01
Mw = 28.60
avg. Pm (-"Hg) = 1.592
avg. Tm (°F) = 83
H_2O (grams or %) = 2.28%
meter volume (ft^3) = 7.594
avg. Ps (+"H_2O) = 4.50
avg. Ts (°F) = 130
time (minutes) = 25
correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#37	Probe & expander	0.0075	24.7524		75.2475		
	0						
51	1	0.0004	1.3201	46.1569	73.9273		
52	2	0.0002	0.6600	19.4609	73.2673	0.0011	29.9709
53	3	0.0035	11.5511	9.3729	61.7161	0.0241	13.5057
54	4	0.0027	8.9108	3.1589	52.8052	0.0125	5.4413
55	5	0.0040	13.2013	1.9944	39.6039	0.0439	2.5100
56	6	0.0037	12.2112	0.9891	27.3927	0.0266	1.4045
57	7	0.0047	15.5115	0.5355	11.8811	0.0386	0.7278
R34	F	0.0036	11.8811				
	Total	0.0303					

ANDERSEN IMPACTOR

Date 6/25/76 Run # 78
Sample volume at STP (ft^3) = 4.3258
Moisture (%) =
Concentration ($grains/ft^3$) = 0.1022
Impactor flow rate (acfm) = 0.3233

Location inlet
Time 1723-1738 (1st well)
Orifice D
bar. press. ("Hg) = 30.01
Mw = 28.60
avg. Pm (-"Hg) = 1.563
avg. Tm (°F) = 85
H_2O (grams or %) = 2.38 %
meter volume (ft^3) = 4.573
avg. Ps (+"H_2O) = 4.50
avg. Ts (°F) = 130
time (minutes) = 15
correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#38	Probe & expander	0.0056	20.0000		80.0000		
	0						
37	1	0.0004	1.4285	46.1342	78.5714		
38	2	0.0000	0.0000	19.4513	78.5714	0.0000	29.9561
39	3	0.0023	8.2142	9.3682	70.3571	0.0264	13.4990
40	4	0.0031	11.0714	3.1573	59.2857	0.0239	5.4386
41	5	0.0053	18.9285	1.9934	40.3571	0.0968	2.5087
42	6	0.0039	13.9285	0.9886	26.4285	0.0467	1.4038
43	7	0.0050	17.8571	0.5352	8.5714	0.0684	0.7274
R33	F	0.0024	8.5714				
	Total	0.0280					

ANDERSEN IMPACTOR

Date 6/25/76 Run # 7C

Sample volume at STP (ft^3) = 4.3009

Moisture (%) =

Concentration (grains/ft^3) = 0.0947

Impactor flow rate (acfm) = 0.3214

Location inlet
Time 1806 - 1821 (2nd inlet)
Orifice D
bar. press. ("Hg) = 30.01
Mw = 28.60
avg. Pm (-"Hg) = 1.55
avg. Tm (°F) = 83.5
H_2O (grams or %) = 2.28 %
meter volume (ft^3) = 4.532
avg. Ps (±"H_2O) = 4.50
avg. Ts (°F) = 130
time (minutes) = 15
correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
TC# 39	Probe & expander	0.0074	28.6821		71.3178		
	0						
30	1	0.0000	0.0000	46.2684	71.3178		
31	2	0.0000	0.0000	19.5081	71.3178	0.0000	30.0435
32	3	0.0003	1.6127	9.3958	70.1550	0.0034	13.5386
33	4	0.0005	1.9379	3.1668	68.2170	0.0038	5.4548
34	5	0.0046	17.8294	1.9995	50.3875	0.0845	2.5164
35	6	0.0097	37.5968	0.9919	12.7906	0.1169	1.4083
36	7	0.0026	10.0775	0.5371	2.7131	0.0358	0.7299
R 32	F	0.0007	2.7131				
	Total	0.0258					

ANDERSEN IMPACTOR

Date 6/25/76 Run # 7

Sample volume at STP (ft^3) = 257.4253

Moisture (%) = 2.1314

Concentration (grains/ft^3) = 0.0006

Impactor flow rate (acfm) = 0.5241

Location outlet East

Orifice E

bar. press. ("Hg) = 30.01

Mw = 28.63

avg. Pm (-"Hg) = 1.96

avg. Tm (°F) = 78

H_2O (grams or %) = 116.0

meter volume (ft^3) = 272.851

avg. Ps (+"H_2O) = 0

avg. Ts (°F) = 125

time (minutes) = 540

correction factor = 1

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#40	Probe & expander	0.0019	17.1171		82.8828		
R16	0	0.0001	0.9009	13.4284	81.9819		
R47	1	0.0006	5.4054	8.4031	76.5765	0.0001	10.6227
R14	2	0.0010	9.0090	5.7114	67.5675	0.0003	6.9278
R45	3	0.0023	20.7207	3.8876	46.8468	0.0008	4.7121
R12	4	0.0020	18.0180	2.4000	28.8288	0.0005	3.0545
R43	5	0.0026	23.4234	1.0311	5.4054	0.0004	1.5731
R10	6	0.0003	2.7027	0.6919	2.7027	0.0001	0.8446
R41	7	0.0003	2.7027	0.4043	0.0000	0.0000	0.5289
R9	F	0.0000	0.0000				
	Total	0.0111					

ANDERSEN IMPACTOR

Date 6/28/76 **Run #** 8A

Sample volume at STP (ft^3) = 5.6092

Moisture (%) =

Concentration (grains/ft^3) = 0.0594

Impactor flow rate (acfm) = 0.3112

Location inlet
Time 0829 - 0849 (back charge, 2nd half)
Orifice
bar. press. ("Hg) = 30.16
Mw = 28.70
avg. Pm (-"Hg) = 1.43
avg. Tm (°F) = 78
H_2O (grams or %) = 1.89 %
meter volume (ft^3) = 5.819
avg. Ps (±"H_2O) = 4.50
avg. Ts (°F) = 127
time (minutes) = 20
correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
B#18	Probe & expander	0.0104	49.0566		50.9433		
	0						
30	1	0.0004	1.8867	46.9587	49.0566		
31	2	0.0004	1.8867	19.8010	47.1698	0.0029	30.4931
32	3	0.0010	4.7169	9.5383	42.4528	0.0088	13.7429
33	4	0.0010	4.7169	3.2167	37.7358	0.0059	5.5391
34	5	0.0018	8.4905	2.0319	29.2452	0.0252	2.5566
35	6	0.0022	10.3773	1.0092	16.8679	0.0202	1.4320
36	7	0.0023	10.8490	0.5478	8.0188	0.0243	0.7435
R 38	F	0.0017	8.0188				
	Total	0.0212					

ANDERSEN IMPACTOR

Date 6/28/76 Run # 8B

Sample volume at STP (ft^3) = 5.5446

Moisture (%) =

Concentration (grains/ft^3) = 0.0338

Impactor flow rate (acfm) = 0.3076

Location inlet
Time 0925–0945 (2nd melt)
Orifice D
bar. press. ("Hg) = 30.16
Mw = 28.70
avg. Pm (-"Hg) = 1.510
avg. Tm (^{o}F) = 83.5
H_2O (grams or %) = 1.89%
meter volume (ft^3) = 5.827
avg. Ps (+"H_2O) = 4.50
avg. Ts (^{o}F) = 127
time (minutes) = 20
correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
B #17	Probe & expander	0.0085	44.7368		55.2631		
	0						
37	1	0,0002	1.0526	47.2322	54.2105		
38	2	0,0000	0.0000	19.9168	54.2105	0.0000	30.6711
39	3	0.0004	2.1052	9.5946	52.1052	0.0035	13.8236
40	4	0.0009	4.7368	3.2361	47.3684	0.0054	5.5722
41	5	0.0017	8.9473	2.0445	38.4210	0.0241	2.5722
42	6	0.0023	12.1052	1.0158	26.3157	0.0214	1.4411
43	7	0,0027	14.2105	0.5517	12.1052	0.0288	0.7486
R 39	F	0.0023	12.1052				
	Total	0.0190					

ANDERSEN IMPACTOR

Date 6/28/76 Run # 8C

Sample volume at STP (ft^3) = 6.9026

Moisture (%) =

Concentration (grains/ft^3) = 0.0485

Impactor flow rate (acfm) = 0.3064

Location inlet

Time 1636-1701 (2nd melt, oxy. lance, alloy add.)

Orifice D

bar. press. ("Hg) = 30.16

Mw = 28.70

avg. Pm (-"Hg) = 1.483

avg. Tm (^{o}F) = 86.7

H_2O (grams or %) = 1.89 %

meter volume (ft^3) = 7.290

avg. Ps (+"H_2O) = 4.50

avg. Ts (^{o}F) = 167

time (minutes) = 25

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC #42	Probe & expander	0.0054	25.3521		74.6478		
	0						
51	1	0.0006	2.8169	47.3287	71.8309		
52	2	0.0002	0.9389	19.9577	70.8920	0.0012	30.7339
53	3	0.0006	2.8169	9.6144	68.0751	0.0043	13.8521
54	4	0.0008	3.7558	3.2430	64.3192	0.0038	5.5838
55	5	0.0027	12.6760	2.0489	51.6431	0.0308	2.5777
56	6	0.0036	16.9014	1.0181	34.7417	0.0270	1.4443
57	7	0.0035	16.4319	0.5530	18.3098	0.0300	0.7504
R40	F	0.0039	18.3098				
	Total	0.0213					

ANDERSEN IMPACTOR

Date 6/28/76 Run # 8D

Sample volume at STP (ft^3) = 4.1009

Moisture (%) =

Concentration ($grains/ft^3$) = 0.0368

Impactor flow rate (acfm) = 0.3034

Location inlet

Time 1734–1749 (before tap – reducing)

data sheet - slag add - reboil

Orifice D

bar. press. ("Hg) = 30.16

Mw = 28.70

avg. Pm (-"Hg) = 1.450

avg. Tm (°F) = 92.5

H_2O (grams or %) = 1.84 %

meter volume (ft^3) = 4.372

avg. Ps (±"H_2O) = 4.50

avg. Ts (°F) = 137

time (minutes) = 15

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#45	Probe & expander	0.0049	51.0416		48.9583		
	0						
15S	1	0.0000	0.0000	47.5633	48.9583		
16	2	0.0001	1.0416	20.0570	47.9166	0.0010	30.8865
17	3	0.0002	2.0833	9.6626	45.8333	0.0024	13.9213
18	4	0.0003	3.1250	3.2596	42.7083	0.0024	5.6122
19	5	0.0007	7.2916	2.0597	35.4166	0.0134	2.5911
20	6	0.0011	11.4583	1.0237	23.9583	0.0138	1.4521
21	7	0.0011	11.4583	0.5564	12.5000	0.0159	0.7547
R41	F	0.0012	12.5000				
	Total	0.0096					

ANDERSEN IMPACTOR

Date 6/28/76 Run # 8

Sample volume at STP (ft^3) = 272.6080

Moisture (%) = 1.4540

Concentration (grains/ft^3) = 0.0009

Impactor flow rate (acfm) = 0.5550

Location outlet East

Orifice E

bar. press. ("Hg) = 30.16

Mw = 28.62

avg. Pm (-"Hg) = 2.119

avg. Tm (°F) = 98

H_2O (grams or %) = 83.8

meter volume (ft^3) = 301.856

avg. Ps (±"H_2O) = 0

avg. Ts (°F) = 128

time (minutes) = 540

correction factor = 1

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC # 43	Probe & expander	0.0039	23.7804		76.2195		
R104	0	0.0002	1.2195	13.0703	75.0000		
R151	1	0.0008	4.8780	8.1774	70.1219	0.0002	10.3383
R122	2	0.0018	10.9756	5.5566	59.1463	0.0006	6.7408
R149	3	0.0031	18.9024	3.7810	40.2439	0.0010	4.5836
R100	4	0.0021	12.8048	2.3328	27.4390	0.0005	2.9699
R147	5	0.0029	17.6829	1.0005	9.7560	0.0004	1.5278
R98	6	0.0014	8.5365	0.6704	1.2195	0.0004	0.8190
R145	7	0.0002	1.2195	0.3902	0.0000	0.0000	0.5115
R31	F	0.0000	0.0000				
	Total	0.0164					

ANDERSEN IMPACTOR

6/28 to Night Run

Date 6/29/76 **Run #** NR #2

Location outlet North

Sample volume at STP (ft^3) = 504.9877

Moisture (%) = 1.0303

Concentration (grains/ft^3) = 0.0005

Impactor flow rate (acfm) = 0.7118

Orifice F

bar. press. ("Hg) = 30.16

Mw = 28.68

avg. Pm (-"Hg) = 1.710

avg. Tm (°F) = 88.5

H_2O (grams or %) = [illegible] ← !

meter volume (ft^3) = 544.075

avg. Ps (+"H_2O) = 0

avg. Ts (°F) = 128

time (minutes) = 780

correction factor = 1

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC #46	Probe & expander	0.0029	14.9484		85.0515		
178 G	0	0.0013	6.7010	11.5305	78.3505		
169 G	1	0.0005	2.5773	7.2070	75.7731	0.0000	9.1159
180 G	2	0.0023	11.8556	4.8918	63.9175	0.0004	5.9376
171 G	3	0.0034	17.5357	3.3237	46.3917	0.0006	4.0323
1372 G	4	0.0029	14.9484	2.0456	31.4432	0.0004	2.6075
173 G	5	0.0026	13.4020	0.8710	18.0412	0.0002	1.3348
1322 G	6	0.0020	10.3092	0.5792	7.7319	0.0003	0.7103
175 G	7	0.0009	4.6391	0.3312	3.0927	0.0001	0.4380
7 GF	F	0.0006	3.0927				
	Total	0.0194					

ANDERSEN IMPACTOR

Date 6/29/76 Run # 9A

Sample volume at STP (ft^3) = 8,3350

Moisture (%) =

Concentration ($grains/ft^3$) = 0.0682

Impactor flow rate (acfm) = 0.3241

Location inlet
Time 0857-0927 (1st melt)
Orifice D
bar. press. ("Hg) = 30.06
Mw = 28.59
avg. Pm (-"Hg) = 1,413
avg. Tm (°F) = 84
H_2O (grams or %) = 2.32 %
meter volume (ft^3) = 8,730
avg. Ps (+"H_2O) = 4.50
avg. Ts (°F) = 155
time (minutes) = 30
correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#48	Probe & expander	0.0091	25.2777		74.7222		
	0						
115	1	0.0010	2.7777	46.5848	71.9444		
11	2	0.0007	1.9444	19.6390	70.0000	0.0035	30.2470
12	3	0.0024	6.6666	9.4565	63.3333	0.0143	13.6278
13	4	0.0042	11.6666	3.1844	51.6666	0.0168	5.4876
14	5	0.0038	10.5555	2.0091	41.1111	0.0360	2.5294
15	6	0.0064	17.7777	0.9946	23.3333	0.0397	1.4136
18	7	0.0058	16.1111	0.5369	7.2222	0.0410	0.7307
R42	F	0.0026	7.2222				
	Total	0.0360					

ANDERSEN IMPACTOR

Date 6/29/76 Run # 9B

Sample volume at STP (ft^3) = 8.1456

Moisture (%) =

Concentration (grains/ft^3) = 0.0532

Impactor flow rate (acfm) = 0.2167

Location inlet

Time 0958 – 1028 (2nd melt)

Orifice D

bar. press. ("Hg) = 30.06

Mw = 28.59

avg. Pm (-"Hg) = 1.443

avg. Tm (°F) = 89

H_2O (grams or %) = 2.32 %

meter volume (ft^3) = 8.672

avg. Ps (±"H_2O) = 4.50

avg. Ts (°F) = 155

time (minutes) = 30

correction factor = —

Oof W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC #49	Probe & expander	0.0069	24.9097		75.0152		
	0						
30	1	0.0009	3.2490	46.9804	71.6111		
31	2	0.0007	2.5270	19.8665	69.3110	0.0025	30.5049
32	3	0.0013	4.6931	9.5378	64.6209	0.0078	13.7445
33	4	0.0021	7.5812	3.2125	57.0397	0.0055	5.5354
34	5	0.0039	14.0794	2.0212	42.9602	0.0375	2.5520
35	6	0.0049	17.6895	1.0040	25.2707	0.0309	1.4267
36	7	0.0048	17.3285	0.5426	7.9422	0.0346	0.7381
R43	F	0.0022	7.9422				
	Total	0.0277					

Reproduced from best available copy.

ANDERSEN IMPACTOR

Date 6/29/76 Run # 9C

Sample volume at STP (ft^3) = 4.1495

Moisture (%) =

Concentration ($grains/ft^3$) = 0.1286

Impactor flow rate (acfm) = 0.3227

Location inlet
Time 1559-1614 (beginning 1st melt)
Orifice D
bar. press. ("Hg) = 30.06
Mw = 28.59
avg. Pm (-"Hg) = 1.40
avg. Tm (°F) = 95
H_2O (grams or %) = 2.32%
meter volume (ft^3) = 4.432
avg. Ps (+"H_2O) = 4.50
avg. Ts (°F) = 155
time (minutes) = 15
correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
TC #50	Probe & expander	0.0075	22.1893		77.8106		
	0						
44	1	0.0009	2.6627	46.6861	75.1479		
45	2	0.0009	2.6627	19.6819	72.4852	0.0091	30.3129
46	3	0.0037	10.9467	9.4773	61.5384	0.0443	13.6577
47	4	0.0028	8.2840	3.1916	53.2544	0.0225	5.4998
48	5	0.0051	15.0887	2.0137	38.1656	0.0970	2.5352
49	6	0.0055	16.2721	0.9970	21.8934	0.0685	1.4169
50	7	0.0052	15.3846	0.5383	6.5088	0.0739	0.7326
R47	F	0.0022	6.5088				
	Total	0.0338					

ANDERSEN IMPACTOR

Date 6/29/76 **Run #** 90

Sample volume at STP (ft^3) = 4.1378

Moisture (%) =

Concentration (grains/ft^3) = 0.1443

Impactor flow rate (acfm) = 0.3218

Location inlet

Time 1652-1707 (and 1st melt)

Orifice D

bar. press. ("Hg) = 30.06

Mw = 28.59

avg. Pm (-"Hg) = 1.50

avg. Tm (°F) = 95

H_2O (grams or %) = 2.32 %

meter volume (ft^3) = 4.435

avg. Ps (+"H_2O) = 4.50

avg. Ts (°F) = 155

time (minutes) = 15

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#51	Probe & expander	0.0078	20.6349		79.3650		
	0						
37	1	0.0010	2.6455	46.7522	76.7195		
38	2	0.0003	0.7936	19.7099	75.9259	0.0030	30.3559
39	3	0.0013	3.4391	9.4909	72.4867	0.0156	13.6771
40	4	0.0029	7.6719	3.1963	64.8148	0.0234	5.5078
41	5	0.0074	19.5767	2.0168	45.2380	0.1412	2.5389
42	6	0.0068	17.9894	0.9986	27.2486	0.0850	1.4191
43	7	0.0062	16.4021	0.5393	10.8465	0.0884	0.7338
51	F	0.0041	10.8465				
	Total	0.0378					

ANDERSEN IMPACTOR

Date 6/29/76 **Run #** 9

Location outlet North

Sample volume at STP (ft^3) = 259.6227

Moisture (%) = 1.7198

Concentration ($grains/ft^3$) = 0.0009

Impactor flow rate (acfm) = 0.5349

Orifice F

bar. press. ("Hg) = 30.06

Mw = 28.59

avg. Pm (-"Hg) = 1.690

avg. Tm (°F) = 92.5

H_2O (grams or %) = 94.4

meter volume (ft^3) = 280.584

avg. Ps (+"H_2O) = 0

avg. Ts (°F) = 133

time (minutes) = 540

correction factor = 1

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC #53	Probe & expander	0.0021	12.7272		87.2727		
R 192	0	0.0006	3.6363	13.3580	83.6363		
R 79	1	0.0009	5.4545	8.3582	78.1818	0.0002	10.5664
R 190	2	0.0017	10.3030	5.6801	67.8787	0.0006	6.8902
R 77	3	0.0028	16.9696	3.8656	50.9090	0.0010	4.6858
R 188	4	0.0031	18.7878	2.3855	32.1212	0.0008	3.0367
R 75	5	0.0036	21.8181	1.0238	10.3030	0.0005	1.5628
R 186	6	0.0011	6.6666	0.6863	3.6363	0.0003	0.8382
R 73	7	0.0002	1.2121	0.4002	2.4242	0.0000	0.5241
R 50	F	0.0004	2.4242				
	Total	0.0165					

ANDERSEN IMPACTOR

6/29 to Night Run

Date 6/30/76 Run # NR #3

Sample volume at STP (ft^3) = 390.7335

Moisture (%) = 1.5386

Concentration ($grains/ft^3$) = 0.0008

Impactor flow rate (acfm) = 0.4830

Location outlet North

Orifice F

bar. press. ("Hg) = 30.06

Mw = 28.59

avg. Pm (-"Hg) = 1.64

avg. Tm (°F) = 93

H_2O (grams or %) = 127.1

meter volume (ft^3) = 422.697

avg. Ps (+"H_2O) = 0

avg. Ts (°F) = 133

time (minutes) = 900

correctinn factor = 1

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
TC#54	Probe & expander	0.0027	12.5581		87.4418		
128	0	0.0010	4.6511	14.0622	82.7906		
121	1	0.0013	6.0465	8.8016	76.7441	0.0002	11.1252
130	2	0.0026	12.0930	5.9836	64.6511	0.0006	7.2571
123	3	0.0037	17.2093	4.0741	47.4418	0.0008	4.9374
132	4	0.0040	18.6046	2.5164	28.8372	0.0007	3.2019
125	5	0.0034	15.8139	1.0827	13.0232	0.0003	1.6506
134	6	0.0019	8.8372	0.7276	4.1860	0.0004	0.8876
127	7	0.0004	1.8604	0.4267	2.3255	0.0000	0.5572
38	F	0.0005	2.3255				
all Gelman Type A	Total	0.0215					

ANDERSEN IMPACTOR

Date 6/30/76 **Run #** 10 A

Sample volume at STP (ft^3) = 4.3048

Moisture (%) =

Concentration ($grains/ft^3$) = 0.0571

Impactor flow rate (acfm) = 0.3237

Location inlet

Time 0829-0844 (bulk charge - [illegible])

Orifice D

bar. press. ("Hg) = 30.03

Mw = 28.68

avg. Pm (-"Hg) = 1.388

avg. Tm (°F) = 82

H_2O (grams or %) = 1.56 %

meter volume (ft^3) = 4.528

avg. Ps (±"H_2O) = 4.50

avg. Ts (°F) = 134

time (minutes) = 15

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#56	Probe & expander	0.0076	48.4076		51.5923		
	0						
15	1	0.0003	1.9108	46.1892	49.6815		
16	2	0.0004	2.5477	19.4741	47.1337	0.0038	29.9916
17	3	0.0006	3.8216	9.3789	43.3121	0.0068	13.5147
18	4	0.0006	3.8216	3.1606	39.4904	0.0046	5.4445
19	5	0.0014	8.9171	1.9952	30.5732	0.0255	2.5112
20	6	0.0012	7.6433	0.9893	22.9299	0.0143	1.4049
21	7	0.0018	11.4649	0.5354	11.4649	0.0245	0.7278
53	F	0.0018	11.4649				
	Total	0.0157					

ANDERSEN IMPACTOR

Date 6/30/76 Run # 108

Sample volume at STP (ft^3) = 4.5332

Moisture (%) =

Concentration ($grains/ft^3$) = 0.0497

Impactor flow rate (acfm) = 0.3196

Location inlet

Time 0915–0931 (2nd inlet)

Orifice D

bar. press. ("Hg) = 30.03

Mw = 28.68

avg. Pm (-"Hg) = 1.50

avg. Tm (°F) = 85.4

H_2O (grams or %) = 1.56%

meter volume (ft^3) = 4.817

avg. Ps (+"H_2O) = 4.50

avg. Ts (°F) = 134

time (minutes) = 16

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
TC#57	Probe & expander	0.0073	50.6944		49.3055		
	0						
51	1	0.0001	0.6944	46.4874	48.6111		
52	2	0.0001	0.6944	19.6005	47.9166	0.0009	30.1857
53	3	0.0004	2.7777	9.4402	45.1388	0.0043	13.6027
54	4	0.0006	4.1666	3.1818	40.9722	0.0043	5.4806
55	5	0.0007	4.8611	2.0089	36.1111	0.0121	2.5282
56	6	0.0013	9.0277	0.9964	27.0833	0.0147	1.4148
57	7	0.0022	15.2777	0.5397	11.8055	0.0285	0.7333
R46	F	0.0017	11.8055				
	Total	0.0144					

ANDERSEN IMPACTOR

Date 6/30/76 Run # 10C

Sample volume at STP (ft^3) = 4.1741

Moisture (%) =

Concentration (grains/ft^3) = 0.0856

Impactor flow rate (acfm) = 0.3139

Location inlet

Time 1459 – 1514 (1st melt-down)

Orifice D

bar. press. ("Hg) = 30.03

Mw = 28.68

avg. Pm (-"Hg) = 1.40

avg. Tm ($^{\circ}$F) = 93.8

H_2O (grams or %) = 1.56 %

meter volume (ft^3) = 4.488

avg. Ps (+"H_2O) = 4.50

avg. Ts ($^{\circ}$F) = 134

time (minutes) = 15

correction factor = —

UofW

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#58	Probe & expander	0.0095	41.6666		58.3333		
	0						
37	1	0.0001	0.4385	46.9086	57.8947		
38	2	0.0010	4.3859	19.7789	53.5087	0.0100	30.4598
39	3	0.0015	6.5789	9.5268	46.9298	0.0177	13.7270
40	4	0.0020	8.7719	3.2117	38.1578	0.0159	5.5315
41	5	0.0031	13.5964	2.0282	24.5614	0.0583	2.5523
42	6	0.0029	12.7192	1.0066	11.8421	0.0357	1.4289
43	7	0.0017	7.4561	0.5457	4.3859	0.0240	0.7411
R45	F	0.0010	4.3859				
	Total	0.0228					

ANDERSEN IMPACTOR

Date 6/30/76 Run # 10D

Sample volume at STP (ft^3) = 4.1698

Moisture (%) =

Concentration ($grains/ft^3$) = 0.0868

Impactor flow rate (acfm) = 0.3135

Location inlet

Time 1549-1604 (2nd melt) ✓

Orifice D

bar. press. ("Hg) = 30.03

Mw = 28.68

avg. Pm (-"Hg) = 1.475

avg. Tm (°F) = 94.4

H_2O (grams or %) = 1.567%

meter volume (ft^3) = 4.500

avg. Ps (±"H_2O) = 4.50

avg. Ts (°F) = 134

time (minutes) = 15

correction factor = —

U of W

	Stage	Net weight (gm)	% on stage	Size cutoff (µm)	% ≤ stated size	dm/d log D	Geo. Mean (µm)
TC #59	Probe & expander	0.0085	36.7965		63.2034		
	0						
44	1	0.0000	0.0000	46.9330	63.2034		
45	2	0.0004	1.7316	19.7892	61.4718	0.0040	30.4757
46	3	0.0009	3.8961	9.5318	57.5757	0.0106	13.7342
47	4	0.0061	26.4069	3.2134	31.1688	0.0485	5.5344
48	5	0.0014	6.0606	2.0293	25.1082	0.0263	2.5537
49	6	0.0016	6.9264	1.0072	18.1818	0.0197	1.4297
50	7	0.0027	11.6883	0.5460	6.4935	0.0381	0.7416
R 44	F	0.0015	6.4935				
	Total	0.0231					

Reproduced from best available copy.

ANDERSEN IMPACTOR

Date 6/30/76 Run # 10

Location outlet North

Sample volume at STP (ft^3) = 275.4868

Moisture (%) = 1.3220

Concentration ($grains/ft^3$) = 0.0008

Impactor flow rate (acfm) = 0.5653

Orifice F

bar. press. ("Hg) = 30.03

Mw = 28.70

avg. Pm (-"Hg) = 1.963

avg. Tm (°F) = 93.2

H_2O (grams or %) = 77.0

meter volume (ft^3) = 302.544

avg. Ps (+"H_2O) = 0

avg. Ts (°F) = 130

time (minutes) = 540

correction factor = 1

	Stage	Net weight (gm)	% on stage	Size cutoff (μm)	% ≤ stated size	dm/d log D	Geo. Mean (μm)
TC#60	Probe & expander	0.0027	18.6206		81.3793		
R184	0	0.0005	3.4482	12.9674	77.9310		
R71	1	0.0009	6.2068	8.1124	71.7241	0.0002	10.2565
R182	2	0.0019	13.1034	5.5120	58.6206	0.0006	6.6870
R69	3	0.0024	16.5517	3.7503	42.0689	0.0008	4.5466
R180	4	0.0027	18.6206	2.3134	23.4482	0.0007	2.9455
R67	5	0.0021	14.4827	0.9917	8.9655	0.0003	1.5146
R178	6	0.0010	6.8965	0.6641	2.0689	0.0003	0.8115
R65	7	0.0002	1.3793	0.3861	0.6896	0.0000	0.5063
56	F	0.0001	0.6896				
	Total	0.0145					

APPENDIX F

FINE PARTICLE MEASUREMENTS

Table F-1. FINE PARTICLE DATA FOR BAGHOUSE INFLUENT, TEST 1

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, ≥ μm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, ≥ μm
1521			9.6×10^6	0.0025	2,400	0.3
1524			1.1×10^7	0.0025	180	0.5
1526			9.2×10^6	0.0025	160	1.0
1529			5.7×10^6	0.0025	0.41	2.0
1533			3.8×10^6	0.0025	2,400	0.3
1535			5.8×10^6	0.0025	2,300	0.3
1537			5.8×10^6	0.0025	2,500	0.3
1539			6.2×10^6	0.0025	2,300	0.3
1541			7.0×10^6	0.0025	2,000	0.3
1543			—	0.0025	29	0.5
1554			7.4×10^6	0.0025	2,200	0.3
1600			5.6×10^6	0.0025	1,600	0.3
1604			7.4×10^6	0.0025	2,300	0.3
1608			4.4×10^6	0.0025	54	0.5
1612			4.1×10^6	0.0025	19	1.0
1616			3.9×10^6	0.0025	0.38	2.0
1619			6.6×10^6	0.0025	2,300	0.3
1624			1.7×10^7	0.0025		
1627			7.7×10^6	0.0025	2,700	0.3
1630			9.3×10^6	0.0025	2,500	0.3
1634			6.6×10^6	0.0025	120	0.5
1637			8.9×10^6	0.0025	22	1.0
1640			8.6×10^6	0.0025	0	2.0
1644			8.0×10^6	0.0025	1,600	0.3
1647			8.0×10^6	0.0025	1,400	0.3
1650			6.0×10^7	0.0025	300	0.3
1654			7.8×10^6	0.0025	20	0.5
1657			8.0×10^6	0.0025	70	1.0
1659			8.1×10^6	0.0025	0.59	2.0
1702			8.2×10^6	0.0025	2,100	0.3
1706			3.3×10^7	0.0025	1,600	0.3
1709			3.0×10^6	0.0025	1,500	0.3
1712			5.7×10^7	0.0025	1,200	0.3
1715			3.8×10^7	0.0025	16	0.5
1718			3.2×10^7	0.0025	23	1.0
1721			2.0×10^7	0.0025	0.00	2.0
1724			2.0×10^6	0.0025	1,600	0.3
1727			2.9×10^6	0.0025	2,400	0.3
1730			5.0×10^7	0.0025	1,300	0.3

Table F-1 (continued). FINE PARTICLE DATA FOR BAGHOUSE INFLUENT, TEST 1

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm
1733			4.3×10^7	0.0025	530	0.5
1735			4.7×10^7	0.0025	140	1.0
1738			2.0×10^7	0.0025	0.33	2.0
1741			2.2×10^7	0.0025	2,400	0.3
1744			2.1×10^7	0.0025	2,000	0.3
1747			3.4×10^7	0.0025	2,200	0.3
1750			4.8×10^7	0.0025	1,500	0.5
1753			3.1×10^7	0.0025	340	1.0
1755			5.4×10^7	0.0025	0.11	2.0
1758			3.2×10^7	0.0025	2,500	0.3
1801			3.1×10^7	0.0025	2,400	0.3
1804			3.2×10^7	0.0025	2,400	0.3
1807			3.7×10^7	0.0025	530	0.5
1810			1.6×10^7	0.0025	550	1.0
1813			1.6×10^7	0.0025	370	1.0
1816			2.6×10^7	0.0025	0.68	2.0
1818			1.9×10^7	0.0025	2,200	0.3
1821			1.2×10^7	0.0025	2,100	0.3
1824			4.0×10^7	0.0025	1,800	0.3
1827			4.4×10^7	0.0025	120	0.5
1830			2.1×10^7	0.0025	48	1.0
1833			1.6×10^7	0.0025	1.2	2.0
1836			4.1×10^7	0.0025	970	0.3
1838			1.9×10^7	0.0025	830	0.3
1841			4.6×10^6	0.0025	1,500	0.3
1843			2.8×10^6	0.0025	320	0.5
1846			2.0×10^6	0.0025	380	1.0
1848			1.2×10^6	0.0025	0.33	2.0
1851			1.1×10^6	0.0025	2,300	0.3
1854			3.1×10^6	0.0025	2,300	0.3
1857			3.7×10^6	0.0025	2,300	0.3
1859			3.1×10^6	0.0025	340	0.5
1902			3.9×10^6	0.0025	140	1.0
1905			2.5×10^6	0.0025	0.0	2.0
1907			2.6×10^6	0.0025	2,200	0.3
1910			3.0×10^6	0.0025	2,200	0.3
1913			6.4×10^6	0.0025	1,900	0.3
1916			6.4×10^6	0.0025	214	0.5
1918			3.8×10^6	0.0025	170	1.0

Table F-1 (continued). FINE PARTICLE DATA FOR BAGHOUSE INFLUENT, TEST 1

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter: Particle concentration, particles/$m^3 \times 10^{-6}$	Condensation nuclei counter: Particle size, $\geq$ μm	Dust counter: Particle concentration, particles/$m^3 \times 10^{-6}$	Dust counter: Particle size, $\geq$ μm
1921			6.3×10^6	0.0025	1.2	2.0
1924			5.1×10^6	0.0025	2,200	0.3
1927			5.7×10^6	0.0025	2,000	0.3
1929			2.5×10^7	0.0025	1,600	0.3
1932			2.8×10^7	0.0025	92	0.5
1934			6.1×10^6	0.0025	26	1.0
1937			3.8×10^7	0.0025	0.11	2.0
1940			5.8×10^7	0.0025	420	0.3
1943			5.8×10^6	0.0025	1,500	0.3
1945			5.0×10^7	0.0025	1,700	0.3
1948			4.9×10^7	0.0025	140	0.5
1950			6.1×10^7	0.0025	19	1.0
1953			6.1×10^7	0.0025	1.1	2.0

Table F-2. FINE PARTICLE DATA FOR BAGHOUSE EFFLUENT, TEST 2

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/m^3 x 10^{-6}	Particle size, ≥ μm	Particle concentration, particles/m^3 x 10^{-6}	Particle size, ≥ μm
1116			5,000	0.0025	17	0.3
1118			6,000	0.0025	11	0.3
1121			12,000	0.0025	7.4	0.3
1126			160,000	0.0025	70	0.3
1128			80,000	0.0025	47	0.3
1130			13,000	0.0025	35	0.3
1132			36,000	0.0025	22	0.3
1143			10,000	0.0025	10	0.3
1146			16,000	0.0025	6.7	0.3
1148			50,000	0.0025	38	0.3
1153			14,000	0.0025	8.4	0.3
1155			14,000	0.0025	4.5	0.3
1158			8,000	0.0025	6.5	0.3
1200			20,000	0.0025	24	0.3
1203			14,000	0.0025	3.4	0.3
1205			14,000	0.0025	3.1	0.3
1208			22,000	0.0025	2.9	0.3
1210			150,000	0.0025	43	0.3
1212			12,000	0.0025	6.1	0.3
1215			10,000	0.0025	3.8	0.3
1217			12,000	0.0025	3.4	0.3
1219			12,000	0.0025	2.4	0.3
1222			80,000	0.0025	61	0.3
1224			20,000	0.0025	8.9	0.3
1226			12,000	0.0025	5.4	0.3
1228			12,000	0.0025	3.7	0.3
1230			10,000	0.0025	3.7	0.3
1233			60,000	0.0025	42	0.3
1235			22,000	0.0025	5.4	0.3
1238			12,000	0.0025	4.8	0.3
1240			10,000	0.0025	3.6	0.3
1242			15,000	0.0025	6.9	0.3
1244			22,000	0.0025	37	0.3
1246			17,000	0.0025	4.0	0.3
1249			15,000	0.0025	3.3	0.3
1252			16,000	0.0025	13	0.3

Table F-2 (continued). FINE PARTICLE DATA FOR BAGHOUSE EFFLUENT, TEST 2

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter: Particle concentration, particles/m^3 x 10^{-6}	Condensation nuclei counter: Particle size, ≥ μm	Dust counter: Particle concentration, particles/m^3 x 10^{-6}	Dust counter: Particle size, ≥ μm
1300			10,000	0.0025	17	0.3
1306			20,000	0.0025	69	0.3
1309			5,200	0.0025	16	0.3
1312			6,600	0.0025	9.2	0.3
1314			4,000	0.0025	14	0.3
1316			8,000	0.0025	25	0.3
1319			170,000	0.0025	64	0.3
1321			115,000	0.0025	34	0.3
1323			100,000	0.0025	18	0.3
1325			58,000	0.0025	19	0.3
1328			44,000	0.0025	56	0.3
1330			70,000	0.0025	32	0.3
1332			38,000	0.0025	37	0.3
1345			20,000	0.0025	55	0.3
1347			18,000	0.0025	5.3	0.3
1349			20,000	0.0025	26	0.3
1353			8,000	0.0025	24	0.3
1405			7,000	0.0025	14	0.3
1408			8,000	0.0025	8.2	0.3
1410			9,500	0.0025	7.4	0.3
1413			110,000	0.0025	60	0.3
1415					2.1	0.5
1416					0.28	1.0
1417					0.04	2.0
1419			11,000	0.0025	9.9	0.3
1422			7,500	0.0025	6.5	0.3
1424			250,000	0.0025	33	0.3
1425					1.1	0.5
1427					0.35	1.0
1428					0.04	2.0
1430			9,000	0.0025	11	0.3
1432			9,000	0.0025	8.2	0.3
1435			12,000	0.0025	23	0.3
1436					1.1	0.5
1438					0.26	1.0
1439					0.02	2.0
1440			12,000	0.0025	4.6	0.3
1443			4,800	0.0025	7.9	0.3

Table F-2 (continued). FINE PARTICLE DATA FOR BAGHOUSE EFFLUENT, TEST 2

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, ≥ μm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, ≥ μm
1445			19,000	0.0025	17	0.3
1449					0.88	0.5
1450					0.35	1.0
1512			38,000	0.0025	55	0.3
1515			33,000	0.0025	36	0.3
1517			28,000	0.0025	20	0.3
1518					0.88	0.5
1519					1.1	1.0
1520					0.11	2.0
1522			33,000	0.0025	39	0.3
1524			20,000	0.0025	14	0.3
1528			18,000	0.0025	6.9	0.3
1529					0.53	0.5
1530					0.64	1.0
1531					0	2.0
1534			29,000	0.0025	14	0.3
1536			20,000	0.0025	7.6	0.3
1538			15,500	0.0025	5.5	0.3
1544					0.35	0.5
1545					0.18	1.0
1546					0.02	2.0
1548			10,000	0.0025	4.6	0.3
1552			14,000	0.0025	2.4	0.3
1555			50,000	0.0025	49	0.3
1556					0.60	0.5
1557					0.21	1.0
1558					0.04	2.0
1600			13,500	0.0025	3.8	0.3
1603			10,000	0.0025	4.7	0.3
1606			22,000	0.0025	23	0.3
1608					0.60	0.5
1609					0.28	1.0
1610					0	2.0
1612			6,500	0.0025	6.6	0.3
1616			200,000	0.0025	27	0.3
1618			18,000	0.0025	11	0.3
1620					0.35	0.5
1621					0.14	1.0

Table F-2 (continued). FINE PARTICLE DATA FOR BAGHOUSE EFFLUENT, TEST 2

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm
1622					0	2.0
1624			13,000	0.0025	3.9	0.3
1626			17,000	0.0025	39	0.3
1629			9,000	0.0025	34	0.3
1631			6,600	0.0025	0.53	0.5
1631½			6,400	0.0025	0.21	1.0
1632			6,800	0.0025	0.02	2.0
1636			9,200	0.0025	3.3	0.3
1637			10,000	0.0025	35	0.3
1640			50,000	0.0025	25	0.3
1642			17,000	0.0025	0.14	0.5
1643			7,000	0.0025	0.18	1.0
1644			7,000	0.0025	0.02	2.0
1648			11,000	0.0025	1.7	0.3
1650			85,000	0.0025	57	0.3
1652			48,000	0.0025	5.6	0.3
1653			39,000	0.0025	0.42	0.5
1654			20,000	0.0025	0.18	1.0
1656			16,000	0.0025	0.04	2.0
1658			14,000	0.0025	6.0	0.3
1700			20,000	0.0025	31	0.3
1702			48,000	0.0025	78	0.3
1704			44,000	0.0025	11	0.5
1704½			34,000	0.0025	5.3	1.0
1705			42,000	0.0025	0.18	2.0

Table F-3. FINE PARTICLE DATA FOR BAGHOUSE EFFLUENT, TEST 4

			Condensation nuclei counter		Dust counter	
Clock time	Phase of process cycle	Compartment being cleaned	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ µm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ µm
1203	Second melt		36,000	0.0025	36	0.3
1205			72,000	0.0025	15	0.3
1208			45,000	0.0025	26	0.3
1210			70,000	0.0025	42	0.3
1212			5,000	0.0025	34	0.3
1216	Tap		28,000	0.0025	44	0.3
1218			27,000	0.0025	40	0.3
1219		10				
1222	First melt		25,000	0.0025	15	0.3
1225			6,000	0.0025	24	0.3
1228			6,000	0.0025	14	0.3
1230		1				
1230			8,000	0.0025	18	0.3
1232			11,000	0.0025	32	0.3
1234			4,000	0.0025	16	0.3
1236			9,000	0.0025	17	0.3
1241		2				
1242½			27,000	0.0025		
1245			4,000	0.0025	21	0.3
1247			3,000	0.0025	11	0.3
1252			1,000	0.0025	4.0	0.3
1252½		3				
1253½			32,000	0.0025		
1255			6,000	0.0025	54	0.3
1257			23,000	0.0025	14	0.3
1259			3,000	0.0025	6.8	0.3
1302			3,000	0.0025	5.0	0.3
1309			4,000	0.0025	5.8	0.3
1311			2,000	0.0025	5.6	0.3
1313			5,000	0.0025	4.3	0.3
1315			6,000	0.0025	18	0.3
1329			4,000	0.0025	15	0.3
1331			3,000	0.0025	4.1	0.3
1337	Back charge	7				
1340	Second melt		29,000	0.0025	48	0.3
1342			35,000	0.0025	24	0.3
1344			1,000	0.0025	6.1	0.3
1348		8				
1350			10,000	0.0025	75	0.3

Table F-3 (continued). FINE PARTICLE DATA FOR BAGHOUSE EFFLUENT, TEST 4

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, ≥ µm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, ≥ µm
1353			12,000	0.0025	53	0.3
1357			4,000	0.0025	26	0.3
1359			8,000	0.0025	28	0.3
1359		9				
1402			62,000	0.0025	25	0.3
1405			8,000	0.0025	8.5	0.3
1408			5,000	0.0025	5.7	0.3
1410			20,000	0.0025	3.5	0.3
1410		10				
1412			54,000	0.0025	31	0.3
1414			22,000	0.0025	13	0.3
1417			10,000	0.0025	5.1	0.3
1421		1				
1429			9,000	0.0025	3.7	0.3
1431			3,000	0.0025	3.1	0.3
1432		2				
1434			32,000	0.0025	36	0.3
1437			10,000	0.0025	5.2	0.3
1439			22,000	0.0025	3.2	0.3
1441			8,000	0.0025	2.1	0.3
1443			10,000	0.0025	1.8	0.3
1444		3				
1446			29,000	0.0025	58	0.3
1449			22,000	0.0025	0.93	0.3
1452			18,000	0.0025	4.3	0.3
1454			14,000	0.0025	3.4	0.3
1455		4				
1456			36,000	0.0025	29	0.3
1459			31,000	0.0025	6.2	0.3
1505			8,000	0.0025	1.9	0.3
1506		5				
1507			57,000	0.0025	53	0.3
1510	Slag off		12,000	0.0025	4	0.3
1415			15,000	0.0025	2.4	0.3
1517		6	14,000	0.0025	1.9	0.3
1520			36,000	0.0025	57	0.3
1527	Reboil		2,000	0.0025	1.6	0.3
1529		7				
1531			27,000	0.0025	39	0.3
1535			30,000	0.0025	3.0	0.3

Table F-3 (continued). FINE PARTICLE DATA FOR BAGHOUSE EFFLUENT, TEST 4

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ µm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ µm
1541		8				
1547			30,000	0.0025	36	
1551	Tap					
1552		9				
1557			50,000	0.0025	21	0.3
1600	First melt		30,000	0.0025	28	0.3
1604		10				
1607			13,000	0.0025	26	0.3
1609			23,000	0.0025	24	0.3
1611			20,000	0.0025	15	0.3
1614			28,000	0.0025	8.4	0.3
1615						
1628			40,000	0.0025	30	0.3
1631			35,000	0.0025	1.1	0.5
1632			30,000	0.0025	0.79	1.0
1634			35,000	0.0025	0.02	2.0
1640			30,000	0.0025	35	0.3
1648			303,000	0.021	21	0.3
1655			40,000	0.021	0.12	0.5
1656			24,000	0.021	0.05	1.0
1656					0.0	2.0
1700			34,000	0.033	9.3	0.3
1702			19,000	0.033	0.28	0.5
1703			19,000	0.033	0.05	1.0
1708			58,000	0.047	0.97	0.3
1710			34,000	0.047	0.23	0.5
1712			48,000	0.047	0.21	1.0
1726			40,000	0.072	0.94	0.3
1727			12,000	0.074	0.11	0.5
1729	Back charge		11,500	0.074	0.02	1.0
1734	Second melt		25,000	0.074	58	0.3
1736			50,000	0.074	38	0.3
1737			50,000	0.074	2.6	0.5
1738			50,000	0.074	1.1	1.0

Table F-4. FINE PARTICLE DATA FOR BAGHOUSE INFLUENT, TEST 5

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, ≥ μm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, ≥ μm
1251	Second melt		5.6×10^5	0.0025	2,000	0.3
1254			5.4×10^5	0.0025	2,000	0.3
1257			3.2×10^6	0.0025	750	0.3
1300			6.3×10^5	0.0025	940	0.3
1307			1.9×10^6	0.0025	320	0.3
1310			1.2×10^6	0.0025	170	0.3
1312			1.6×10^6	0.0025	140	0.3
1314			2.6×10^6	0.0025	120	0.3
1316			5.4×10^5	0.0025	180	0.3
1318			7.8×10^5	0.0025	200	0.3
1321			7.4×10^6	0.0025	80	0.3
1323			1.1×10^6	0.0025	220	0.3
1325			1.9×10^6	0.0025	160	0.3
1327			2.1×10^6	0.0025	150	0.3
1330			2.0×10^6	0.0025	100	0.3
1332			2.0×10^6	0.0025	160	0.3
1340			8.2×10^6	0.0025	70	0.3
1343			7.6×10^5	0.0025	63	0.3
1345			1.2×10^6	0.0025	77	0.3
1347			2.7×10^6	0.0025	85	0.3
1349			2.2×10^6	0.0025	84	0.3
1351			2.4×10^6	0.0025	61	0.3
1358			4.9×10^6	0.0025	1,200	0.3
1400			4.4×10^6	0.0025	850	0.3
1403			5.0×10^6	0.0025	290	0.3
1405			6.9×10^6	0.0025	240	0.3
1407			1.1×10^7	0.0025	250	0.3
1410	Slag off		8.0×10^6	0.0025	230	0.3
1413			2.7×10^6	0.0025	95	0.3
1415			2.1×10^6	0.0025	250	0.3
1419			5.4×10^6	0.0025	600	0.3
1422			6.5×10^6	0.0025	2,100	0.3
1425			9.5×10^6	0.0025	120	0.3
1427			7.9×10^6	0.0025	470	0.3
1429			8.1×10^6	0.0025	470	0.3
1431			1.1×10^7	0.0025	220	0.3
1432			1.2×10^7	0.0025	220	0.3
1435			1.3×10^7	0.0025	110	0.3
1437			1.0×10^7	0.0025	72	0.3
1440			4.3×10^6	0.0025	380	0.3

Table F-4 (continued). FINE PARTICLE DATA FOR BAGHOUSE INFLUENT, TEST 5

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/ $m^3 \times 10^{-6}$	Particle size, ≥ μm	Particle concentration, particles/ $m^3 \times 10^{-6}$	Particle size, ≥ μm
1442			4.6×10^6	0.0025	1,600	0.3
1444	Reboil		4.8×10^6	0.0025	1,500	0.3
1446			4.4×10^6	0.0025	290	0.3
1448			5.0×10^6	0.0025	310	0.3
1450			4.4×10^6	0.0025	570	0.3
1453			1.1×10^7	0.0025	270	0.3
1459			4.0×10^6	0.0025	300	0.3
1501			4.1×10^6	0.0025	1,500	0.3
1504			3.5×10^6	0.0025	1,300	0.3
1506			3.9×10^6	0.0025	1,400	0.3
1515	Tap		1.1×10^7	0.0025	3,500	0.3
1517			1.2×10^7	0.0025	4,700	0.3
1519	First melt		1.2×10^7	0.0025	4,900	0.3
1521			3.5×10^6	0.0025	2,900	0.3
1523			3.7×10^6	0.0025	990	0.3
1525			2.3×10^6	0.0025	2,600	0.3
1527			6.3×10^6	0.0025	4,300	0.3
1529			7.5×10^6	0.0025	2,500	0.3
1531			8.5×10^6	0.0025	2,100	0.3
1533			6.5×10^6	0.0025	2,800	0.3
1535			8.2×10^6	0.0025	2,700	0.3
1538			1.6×10^7	0.0025	1,800	0.3
1600			2.8×10^6	0.021	440	0.3
1613			8.9×10^6	0.021	150	0.3
1616			1.0×10^6	0.021	250	0.3
1619	Back charge		7.0×10^6	0.021	220	0.3
1622			4.2×10^6	0.021	190	0.3
1624	Second melt		3.4×10^6	0.021	830	0.3
1625			1.7×10^6	0.021	4,200	0.3
1628			1.6×10^6	0.021	1,400	0.3
1634			3.5×10^6	0.033	190	0.3
1636			1.3×10^6	0.033	210	0.3
1638			1.1×10^6	0.033	470	0.3
1642			2.2×10^6	0.033	540	0.3
1644			1.4×10^6	0.033	150	0.3
1646			2.2×10^6	0.033	270	0.3
1652			1.6×10^6	0.048	580	0.3
1655			9.9×10^6	0.048	590	0.3
1658			3.0×10^6	0.048	260	0.3
1700			1.3×10^6	0.071	400	0.3

Table F-4 (continued). FINE PARTICLE DATA FOR BAGHOUSE INFLUENT, TEST 5

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm
1703			1.2×10^6	0.071	600	0.3
1705			1.5×10^6	0.071	480	0.3
1707			1.1×10^6	0.071	690	0.3
1711			2.5×10^6	0.048	660	0.3
1714			5.2×10^6	0.048	120	0.3
1721			1.2×10^7	0.014	130	0.3
1724			1.3×10^7	0.014	87	0.3
1728			1.3×10^7	0.014	140	0.3
1730	Slag off		1.4×10^7	0.014	750	0.3
1733			1.3×10^7	0.014	110	0.3

Table F-5. FINE PARTICLE DUST FOR BAGHOUSE EFFLUENT, TEST 6

			Condensation nuclei counter		Dust counter	
Clock time	Phase of process cycle	Compartment being cleaned	Particle concentration, particles/m^3 x 10^{-6}	Particle size, $\geq$ μm	Particle concentration, particles/m^3 x 10^{-6}	Particle size, $\geq$ μm
1050	First melt		2,000	0.0025	29	0.3
1054			2,000	0.0025	22	0.3
1057		#10	90,000	0.0025	15	0.3
1059			12,000	0.0025	16	0.3
1105			5,000	0.0025	14	0.3
1108		#1	43,000	0.0025	28	0.3
1113			14,000	0.0025	53	0.3
1119		#2	4,000	0.0025	32	0.3
1121			22,000	0.0025	30	0.3
1124			4,000	0.0025	18	0.3
1129		#3	12,000	0.0025	14	0.3
1135			12,000	0.0025	12	0.3
1140		#4	7,000	0.0025	1.8	0.3
1144			72,000	0.0025	21	0.3
1147			21,000	0.0025	3.4	0.3
1150			12,000	0.0025	3.3	0.3
1152		#5	6,000	0.0025	1.8	0.3
1156	Back charge		12,000	0.0025	19	0.3
1226	Second melt	#8	85,000	0.0025	33	0.3
1230			54,000	0.0025	11	0.3
1232			39,000	0.0025	4.0	0.3
1235			33,000	0.0025	3.1	0.3
1237		#9	90,000	0.0025	17	0.3
1243			70,000	0.0025	6.9	0.3
1245			35,000	0.0025	3.7	0.3
1247			36,000	0.0025	1.6	0.3
1249		#10	85,000	0.0025	4.8	0.3
1253			25,000	0.0025	4.8	0.3
1256			25,000	0.0025	2.7	0.3
1300		#1	26,000	0.0025	3.6	0.3
1303			11,000	0.0025	2.1	0.3
1307			11,000	0.0025	1.0	0.3
1309			4,000	0.0025	1.5	0.3
1310	Slag off	#2				
1313			30,000	0.0025	17	0.3
1316			3,000	0.0025	1.9	0.3
1319			3,000	0.0025	1.4	0.3
1321		#3				

Table F-5 (continued). FINE PARTICLE DUST FOR BAGHOUSE EFFLUENT, TEST 6

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, ≥ μm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, ≥ μm
1323			41,000	0.0025	31	0.3
1325			38,000	0.0025	6.8	0.3
1327			25,000	0.0025	2.8	0.3
1331			6,000	0.0025	2.7	0.3
1333		#4				0.3
1334	Reboil		30,000	0.0025	29	0.3
1337			7,000	0.0025	4.9	0.3
1340			8,000	0.0025	2.5	0.3
1344			100,000	0.0025	1.2	0.3
1349			3,000	0.0025	6.9	0.3
1352			4,000	0.0025	5.3	0.3
1355		#6	4,000	0.0025	3.2	0.3
1357			22,000	0.0025	5.2	0.3
1400	Tap		11,000	0.0025	8.2	0.3
1402			8,000	0.0025	8.6	0.3
1405			4,000	0.0025	7.9	0.3
1406		#4				
1407			36,000	0.0025	44	0.3
1409	First melt		3,000	0.0025	8	0.3
1416		#7	3,000	0.0025	1.8	0.3
1420			31,000	0.015	48	0.3
1426			34,000	0.015	3.1	0.3
1430			80,000	0.015	32	0.3
1432		#9	68,000	0.015	6.2	0.3
1439			14,000	0.015	9.7	0.3
1445			11,000	0.015	23	0.3
1452			50,000	0.015	5.6	0.3
1455			9,000	0.015	2.4	0.3
1458		#1	3,000	0.015	1.4	0.3
1504			38,000	0.015	31	0.3
1506			19,000	0.015	2.1	0.3
1510			7,000	0.015	1.1	0.3
1516			17,000	0.015	5.7	0.3
1520	Back charge	#3	8,000	0.015	1.8	0.3

Table F-5 (continued). FINE PARTICLE DUST FOR BAGHOUSE EFFLUENT, TEST 6

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, ≥ μm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, ≥ μm
1524	Second melt		16,000	0.015	1.3	0.3
1547			69,000	0.021	40	0.3
1550			45,000	0.021	1.1	0.3
1553			24,000	0.021	0.78	0.3
1557			28,000	0.0025	0.87	0.3
1601			20,000	0.033	3.3	0.3
1603			5,000	0.033	2.9	0.3
1605			2,000	0.033	2.9	0.3
1609			7,000	0.0025	1.9	0.3
1615			10,000	0.048	7.0	0.3
1618			20,000	0.048	6.6	0.3
1621			13,000	0.078	18	0.3
1623			13,000	0.078	8.5	0.3
1630	Slag off		40,000	0.078	110	0.3
1630					14	0.5
1630					11	1.0
1630					3.5	2.0
1630					3.5	3.0
1630					1.8	3.0
1630			36,000		3.5	2.0
1632					11	1.0
1632		Unknown			2100	0.5
1632					3500	0.3
1634					350	0.5
1634					35	1.0
1634					18	2.0
1634					11	3.0
1634					3.5	5.0
1634					1.8	10.0
1635					140	0.3

Table F-6. FINE PARTICLE DATA FOR BAGHOUSE INFLUENT, TEST 7

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm
1258	Tap		1.7×10^7	0.0025	—	—
1303	First melt		1.4×10^7	0.0025	—	—
1308			1.3×10^7	0.0025	—	—
1314			1.0×10^7	0.0025	—	—
1316			8.8×10^6	0.0025	—	—
1323			8.0×10^6	0.0025	—	—
1325			8.1×10^6	0.0025	—	—
1334			8.1×10^6	0.0025	—	—
1336			1.7×10^7	0.0025	—	—
1340			1.3×10^7	0.0025	—	—
1345			4.4×10^6	0.0025	—	—
1350			3.9×10^6	0.0025	—	—
1355			8.4×10^6	0.0025	—	—
1402			1.7×10^7	0.0025	—	—
1416			3.8×10^6	0.0025	—	—
1421	Back charge		4.3×10^6	0.0025	—	—
1431	Second melt		1.3×10^7	0.0025	—	—
1441			9.1×10^6	0.0025	—	—
1444			1.0×10^7	0.0025	—	—
1451			7.4×10^6	0.0025	—	—
1456			9.5×10^6	0.0025	—	—
1502			1.0×10^7	0.0025	—	—
1508			8.9×10^6	0.0025	—	—
1525			5.4×10^6	0.0025	650	0.3
1528			9.4×10^6	0.0025	540	0.3
1530			1.7×10^7	0.0025	560	0.3
1532			1.7×10^7	0.0025	510	0.3
1534	Slag off		8.2×10^6	0.0025	530	0.3
1536			3.9×10^6	0.0025	570	0.3
1538			2.6×10^6	0.0025	540	0.3
1540			5.3×10^6	0.0025	580	0.3
1551			4.0×10^6	0.0025	600	0.3
1553			5.7×10^6	0.0025	840	0.3
1555			3.7×10^6	0.0025	480	0.3
1559			2.0×10^7	0.0025	530	0.3
1601			1.4×10^7	0.0025	540	0.3
1603			1.6×10^7	0.0025	280	0.3
1605			1.7×10^7	0.0025	280	0.3
1608			1.5×10^7	0.0025	360	0.3

Table F-6 (continued). FINE PARTICLE DATA FOR BAGHOUSE INFLUENT, TEST 7

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm
1611			1.8×10^7	0.0025	260	0.3
1617	Reboil		2.8×10^6	0.015	400	0.3
1631			5.0×10^6	0.015	79	0.3
1633			4.3×10^6	0.015	130	0.3
1635	Tap		5.6×10^6	0.015	59	0.3
1638			1.1×10^7	0.015	54	0.3
1641	First melt		1.1×10^7	0.015	39	0.3
1644			3.2×10^6	0.015	150	0.3
1646			4.0×10^6	0.015	310	0.3
1648			3.3×10^6	0.015	320	0.3
1650			3.8×10^6	0.015	190	0.3
1652			2.2×10^6	0.015	170	0.3
1654			1.9×10^6	0.015	540	0.3
1656			1.1×10^7	0.015	2,200	0.3
1700			1.7×10^7	0.015	1,100	0.3
1710			2.2×10^7	0.0025	610	0.3
1713			2.2×10^7	0.0025	890	0.3
1715			1.9×10^7	0.0025	960	0.3
1717			1.5×10^7	0.0025	680	0.3
1719			1.7×10^7	0.0025	1,800	0.3
1721			8.2×10^6	0.0025	1,900	0.3
1723			8.5×10^6	0.0025	3,800	0.3
1725			1.6×10^7	0.0025	4,200	0.3

Table F-7. FINE PARTICLE DATA FROM BAGHOUSE EFFLUENT, TEST 8

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ µm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ µm
1130	First melt		29,000	0.0025	21	0.3
1133			50,000	0.0025	6.8	0.3
1135			22,000	0.0025	7.6	0.3
1138			3,500	0.0025	4.0	0.3
1140		#10	15,000	0.0025	23	0.3
1142			9,000	0.0025	7.4	0.3
1143			24,000	0.0025	4.2	0.3
1153			2,000	0.0025	2.5	0.3
1155			5,000	0.0025	1.8	0.3
1158			8,000	0.0025	1.8	0.3
1200			5,000	0.0025	4.4	0.3
1202		#1	32,000	0.0025	25	0.3
1204			4,000	0.0025	2.6	0.3
1206			4,000	0.0025	1.6	0.3
1214			95,000	0.0025	15	0.3
1216			65,000	0.0025	16	0.3
1219			14,000	0.0025	7.1	0.3
1221			7,000	0.0025	5.6	0.3
1223			10,000	0.0025	7.8	0.3
1225	Back charge		4,000	0.0025	3.1	0.3
1227			4,500	0.0025	11	0.3
1229	Second melt		7,500	0.0025	7.0	0.3
1231			24,000	0.0025	1.8	0.3
1235			25,000	0.0025	26	0.3
1236			55,000	0.0025	8.1	0.3
1238			25,000	0.0025	1.8	0.3
1241			12,000	0.0025	2.4	0.3
1243			10,000	0.0025	1.5	0.3
1245		#5	15,000	0.0025	29	0.3
1247			50,000	0.0025	27	0.3
1252			15,000	0.0025	2.1	0.3
1254			10,000	0.0025	0.90	0.3
1256			12,000	0.0025	1.3	0.3
1258			52,000	0.0025	46	0.3
1300			25,000	0.0025	2.7	0.3
1301			15,000	0.0025	2.68	0.3
1305			17,000	0.0025	1.5	0.3

Table F-7 (continued). FINE PARTICLE DATA FROM BAGHOUSE EFFLUENT, TEST 8

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ µm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ µm
1307	Slag off	Shake	8,000	0.0025	1.3	0.3
1310			115,000	0.0025	62	0.3
1312			130,000	0.0025	26	0.3
1314			70,000	0.0025	10	0.3
1316			65,000	0.0025	4.8	0.3
1319			35,000	0.0025	4.5	0.3
1324			35,000	0.0025	6.2	0.3
1331			185,000	0.0025	24	0.3
1333			100,000	0.0025	7.5	0.3
1335			13,000	0.0025	5.0	0.3
1337			8,500	0.0025	3.8	0.3
1339			15,000	0.0025	2.9	0.3
1341			34,000	0.0025	4.7	0.3
1343			40,000	0.0025	37	0.3
1345			34,000	0.0025	2.4	0.3
1355			16,000	0.0025	7.2	0.3
1357			17,000	0.0025	2.5	0.3
1359			12,000	0.0025	1.2	0.3
1400			9,000	0.0025	1.5	0.3
1404			50,000	0.0025	47	0.3
1406			58,000	0.0025	11	0.3
1409	Reboil		41,000	0.0025	3.7	0.3
1600	First melt		4,000	0.021	19	0.3
1603			3,000	0.021	13	0.3
1603			5,000	0.021	0	0.5
1611			4,000	0.033	6.8	0.3
1615			14,000	0.033	3.9	0.3
1621			6,600	0.047	16	0.3
1635			11,000	0.078	16	0.3

Table F-8. FINE PARTICLE DATA FOR BAGHOUSE INFLUENT, TEST 9

			Condensation nuclei counter		Dust counter	
Clock time	Phase of process cycle	Compartment being cleaned	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm
1120	Second melt		8.4×10^6	0.0025	2.3×10^4	0.3
1124			4.3×10^6	0.0025	3.0×10^4	0.3
1126			5.3×10^6	0.0025	2.8×10^4	0.3
1128			1.3×10^7	0.0025	2.4×10^3	0.5
1130			5.7×10^6	0.0025	300	1.0
1132			6.7×10^6	0.0025	4	2.0
1134			1.2×10^6	0.0025	2.7×10^4	0.3
1136			5.7×10^6	0.0025	2.7×10^4	0.3
1138			1.1×10^7	0.0025	2.5×10^4	0.3
1144	Reboil		8×10^6	0.0025	3.5×10^4	0.3
1146			9.8×10^6	0.0025	410	0.5
1148			9.1×10^6	0.0025	140	1.0
1150			9.1×10^6	0.0025	3	2.0
1152			6.3×10^6	0.0025	2.5×10^4	0.3
1154			9.9×10^6	0.0025	2.9×10^4	0.3
1156			7.6×10^6	0.0025	2.8×10^4	0.3
1204			6.8×10^6	0.0025	3.6×10^4	0.3
1206			5.4×10^6	0.0025	3.4×10^4	0.3
1208			4.4×10^6	0.0025	6.3×10^3	0.5
1210	Tap		3.1×10^6	0.0025	730	1.0
1212			6.3×10^6	0.0025	6	2.0
1215	First melt		7.1×10^6	0.0025	2.5×10^4	0.3
1220			1.0×10^7	0.0025	3.0×10^4	0.3
1227			5.1×10^6	0.0025	3.0×10^4	0.3
1250			6.0×10^6	0.0025	2.2×10^4	0.3
1252			4.9×10^6	0.0025	2.0×10^4	0.3
1255			6.1×10^6	0.0025	2.0×10^4	0.3
1258			6.3×10^6	0.0025	970	0.5
1304			6.0×10^6	0.0025	2.2×10^4	0.3
1306			8.4×10^6	0.0025	2.1×10^4	0.3
1308			7.6×10^6	0.0025	2.2×10^4	0.3
1311			7.5×10^6	0.0025	1.3×10^3	0.5
1314			1.2×10^7	0.0025	330	1.0
1316			9.4×10^6	0.0025	22	2.0
1318			3.5×10^6	0.0025	8	3.0
1320	Back charge		4.8×10^6	0.0025	9	5.0
1322	Second melt		1.1×10^7	0.0025	18	10.0
1340			5.5×10^6	0.0025	19	0.3
1343			1.1×10^7	0.0025	37	0.3

Table F-8 (continued). FINE PARTICLE DATA FOR BAGHOUSE INFLUENT, TEST 9

			Condensation nuclei counter		Dust counter	
Clock time	Phase of process cycle	Compartment being cleaned	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq$ μm
1346			3.6×10^6	0.0025	2.1×10^4	0.3
1349			7.8×10^6	0.0025	1.1×10^3	0.5
1352			5.1×10^6	0.0025	550	1.0
1354			7.7×10^6	0.0025	16	2.0
1356			1.7×10^7	0.0025	16	3.0
1358			3.0×10^6	0.0025	17	5.0
1400			1.5×10^6	0.0025	16	10.0
1405			4.5×10^6	0.0025	2.2×10^4	0.3
1407			5.2×10^6	0.0025	2.6×10^4	0.3
1409			3.6×10^6	0.0025	2.4×10^4	0.3
1411			5.7×10^6	0.0025	1.2×10^3	0.5
1413			1.3×10^7	0.0025	350	1.0
1416			5.1×10^6	0.0025	16	2.0
1418			3.2×10^6	0.0025	16	3.0
1421			4.2×10^6	0.0025	15	5.0
1423			5.1×10^6	0.0025	16	10.0
1459			2.2×10^6	0.015	2.6×10^4	0.3
1501			1.4×10^6	0.015	2.6×10^4	0.3
1503			3.0×10^6	0.015	1.2×10^3	0.5
1505	Slag off		9.0×10^6	0.015	190	1.0
1507			2.9×10^6	0.015	19	2.0
1509			8.0×10^6	0.015	20	3.0
1511			8.6×10^6	0.015	18	5.0
1513	Reboil		9.8×10^6	0.015	18	10.0
1525			3.5×10^6	0.048	6.0×10^3	0.3
1527			1.9×10^6	0.048	5.9×10^3	0.3
1530			1.5×10^6	0.048	1.1×10^3	0.5
1532			3.1×10^6	0.048	7.9×10^3	0.5
1534			2.0×10^6	0.048	7.2×10^3	0.3
1536			1.3×10^6	0.068	6.4×10^3	0.3
1538			1.3×10^6	0.068	3.6×10^3	0.3
1540			9.2×10^5	0.068	4.4×10^3	0.5
1542	Tap		7.9×10^5	0.068	1.6×10^3	1.0
1550	First melt		3.4×10^6	0.033	9.2×10^3	0.3
1552			1.5×10^6	0.033	5.3×10^3	0.5
1554			8.1×10^5	0.033	3.0×10^3	1.0
1556			1.2×10^6	0.033	18	2.0
1600			1.3×10^6	0.021	1.6×10^3	0.3
1602			8.4×10^5	0.021	5.3×10^3	0.5
1604			1.2×10^6	0.021	4.0×10^3	1.0
1606			1.2×10^6	0.021	20	2.0

Table F-9. FINE PARTICLE DATA FOR BAGHOUSE EFFLUENT TEST, 10

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/m^3 x 10^{-6}	Particle size, ≥ μm	Particle concentration, particles/m^3 x 10^{-6}	Particle size, ≥ μm
1229	Second melt		31,000	0.0025	67	0.3
1231			19,000	0.0025	67	0.3
1233			14,000	0.0025	67	0.3
1235			9,000	0.0025	67	0.3
1237			60,000	0.0025	66	0.3
1239			80,000	0.0025	69	0.3
1241			29,000	0.0025	69	0.3
1243			25,000	0.0025	68	0.3
1245			21,000	0.0025	67	0.3
1247			19,000	0.0025	67	0.3
1249			89,000	0.0025	42	0.5
1251			60,000	0.0025	20	0.5
1253			24,000	0.0025	8.8	0.5
1255			11,000	0.0025	9.3	0.5
1257			9,000	0.0025	7.1	0.5
1259			14,000	0.0025	6.0	0.5
1301			22,000	0.0025	14	1.0
1303			21,000	0.0025	2.9	1.0
1305			18,000	0.0025	2.0	1.0
1307			3,000	0.0025	1.8	1.0
1309	Slag off		7,000	0.0025	0.0	2.0
1311			80,000	0.0025	1.0	2.0
1314			21,000	0.0025	71	0.3
1316			9,000	0.0025	6.1	0.5
1318			11,000	0.0025	1.6	1.0
1321			5,000	0.0025	0.0	2.0
1323			26,000	0.0025	67	0.3
1325			12,000	0.0025	70	0.3
1327			21,000	0.0025	66	0.3
1329			15,000	0.0025	4.7	0.5
1331			13,000	0.0025	1.27	1.0
1333			10,000	0.0025	0.06	2.0
1335			80,000	0.0025	59	0.3
1338			49,000	0.0025	61	0.3
1340	Reboil		50,000	0.0025	65	0.3
1342			47,000	0.0025	29	0.5
1344			30,000	0.0025	14	1.0
1346			170,000	0.0025	0.64	2.0
1348			55,000	0.0025	70	0.3
1349			32,000	0.0025	71	0.3

Table F-9 (continued). FINE PARTICLE DATA FOR BAGHOUSE EFFLUENT TEST, 10

Clock time	Phase of process cycle	Compartment being cleaned	Condensation nuclei counter		Dust counter	
			Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq \mu m$	Particle concentration, particles/$m^3 \times 10^{-6}$	Particle size, $\geq \mu m$
1351			25,000	0.0025	73	0.3
1353			32,000	0.0025	31	0.5
1355			24,000	0.0025	14	1.0
1357			16,000	0.0025	0.80	2.0
1359			30,000	0.0025	70	0.3
1401	Tap		20,000	0.0025	72	0.3
1403			24,000	0.0025	64	0.3
1405	First melt		24,000	0.0025	10	0.5
1407			25,000	0.0025	38	1.0
1409			10,000	0.0025	0.74	2.0
1411			3,000	0.0025	68	0.3
1413			4,000	0.0025	67	0.3
1417			8,000	0.0025	69	0.3
1419			5,000	0.0025	75	0.3
1454			12,000	0.015	78	0.3
1456			8,000	0.015	72	0.3
1502			3,000	0.021	70	0.3
1504			12,000	0.021	79	0.3
1506			25,000	0.021	65	0.3
1509			5,000	0.021	65	0.3
1511			8,000	0.021	5.4	0.5
1513			7,000	0.021	8.7	1.0
1515	Back charge		10,000	0.021	80	0.3
1517	Second melt		1,600	0.021	74	0.3
1535			18,000	0.033	77	0.3
1537			14,000	0.033	74	0.3
1539			33,000	0.033	34	0.5
1545			11,000	0.033	106	0.5
1547			14,000	0.033	74	0.3
1555			8,000	0.078	69	0.3
1557			5,000	0.078	72	0.3
1559			13,000	0.078	9.1	0.5
1601			13,000	0.078	37	1.0
1603			14,000	0.078	9.1	0.5
1605			14,000	0.078	2.7	1.0
1607			7,000	0.048	64	0.3
1609			10,000	0.048	70	0.3
1611			16,000	0.048	79	0.3
1613			13,000	0.048	5.4	0.5
1616			14,000	0.048	11	0.5
1618			8,000	0.048	2.1	1.0